# Essais sur la libéralisation commerciale et les inégalités de revenus dans les pays en développement

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# ESSAYS ON TRADE LIBERALIZATION AND INCOME INEQUALITY IN DEVELOPING COUNTRIES

THESE NOUVEAU REGIME
Présentée et soutenue publiquement
Pour l'obtention du titre de Docteur ès Sciences Economiques

Par
Julien Gourdon

Sous la Direction de
M. le Professeur Jaime de Melo

OCTOBRE 2007

Membres du Jury :

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| Directeurs | Jaime de Melo, Professeur à l'Université de Genève. |
| Rapporteurs | Marcelo Olarreaga, Professeur à l'Université de Genève. |
| | Lionel Fontagné, Professeur à l'Université de Paris Sorbonne. |
| Suffragants | Patrick Guillaumont, Professeur à l'Université d'Auvergne (CERDI). |

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La faculté n'entend donner aucune approbation ou improbation aux opinions émises dans cette thèse. Ces opinions doivent être considérées comme propre à leur auteur.

La réalisation de ce travail n'aurait été possible sans l'aide des membres du CERDI, sans les nombreux conseils des chercheurs invités au CERDI et sans les échanges avec des participants à des colloques extérieurs. Qu'ils en soient remerciés.

Je tiens tout particulièrement à exprimer ma reconnaissance à
Jaime de Melo.

Enfin, merci au soutien constant apporté par famille et amis, ainsi qu'à leur inépuisable patience.

**CONTENTS**

# INTRODUCTION

## Globalisation process and the link with Poverty in developing countries

In the age of globalization, the question whether inequality in the world rose or fell down in developing countries during their integration into the world trading system is a hot topic. There is more than ever talk and writing on globalization and one of its apparent effects—increased inequality.

To anti-globalization protesters, "transnational corporations . . . expand, invest and grow, concentrating ever more wealth in a limited number of hands." Agents such as the International Monetary Fund (IMF) and World Bank are said to be aiming at an outcome "in which all productive assets are owned by foreign corporations producing for export." Recently, "globalization from above" has shifted "towards a more destructive phase, marked by increased militarization, worldwide recession, and increased economic inequality." The protesters usually claim that globalization is a disaster for the workers, throwing them into "downward wage spirals in both the North and the South.".

## Economists view on the subject

Economists find such rhetoric hard to take, since the neoclassical model of growth identifies at least three ways in which globalization makes the poor of the world better off. Let us define globalization as the movement across international borders of goods and factors of production and adopt the standard assumption of the neoclassical model that poor countries are poor

because of lower capital per worker. Let us identify the world's poor as largely belonging to the group of unskilled workers in poor countries. Then globalization has three beneficial channels for poor workers: (1) It gives them access to inflows of capital, which will raise the marginal product of labor and thus wages (part of which can be taken in the form of increased health and safety benefits and shorter hours), (2) It gives them some opportunity to migrate to rich countries, where their wages will be higher; and (3) It gives them market access for their goods, raising the wages of unskilled workers in labor abundant countries, at least according to textbook trade theory.

**Approach**

In this thesis, we focus on this third channel to measure the impact of globalization on poor workers. So we use one of the several aspects of globalization: openness to trade. But we have to be more precise about how we define "openness". Too often, the word 'openness' has been used to embrace the entire scope of policies and outcomes that characterise a "healthy" economy. But this makes 'openness' unachievable from a policy point of view. Here, we use the word to refer narrowly to an open trade policy stance, the opposite of protectionism. Defined this way, 'openness' does not, unfortunately, guarantee growth, and in some circumstances it makes poverty reduction more difficult. Effectively openness is not necessarily good for the poor. Often, reducing trade protection has not brought growth to today's poorest countries and has not been particularly good for the poorest households within many developing countries. This thesis indicates several channels through which openness, as we know it today, is fundamentally asymmetric in its benefits and its risks, as it could works less well for the currently poor countries and for poor households within developing countries.

**Inequality rather than poverty**

In this thesis, I focus on inequality rather than on poverty. Several authors argue that it seems better to focus on impoverishment than on inequality. However if inequality were not something we cared about, it is also very difficult to explain the concern with poverty. Effectively if all incomes are fair or if other people's incomes do not enter our welfare function, why should we care if they are many poor people?

High levels of income inequality lead from several ways to increasing poverty. First, keeping constant a level of income, a high level of inequality means a high level of poverty since people at the bottom of the distribution obtain a less important share of resources. Secondly, a high level of inequality could lead to a low future growth and consequently less reduction in poverty (if growth is good for the poor). The negative impact of inequality on growth could appear through several channels, such as credit access constraint for the poor. Third, a high level of inequality will reduce the benefit from growth for the poor since a high initial level of inequality will reduce the share of benefit from growth for the poor.

Independently of the inequality's impact on poverty, inequality has a negative direct impact on social welfare. According to the theory on relative deprivation, individuals and households do not evaluate their social welfare only in terms of absolute income. They also compare themselves to others. Consequently, keeping constant the income level in a country, a high level of inequality has a negative direct impact on social welfare.

**The failure of conventional wisdom and recent developments**

The conventional wisdom states the hypothesis that countries trade according to their comparative advantage in factors endowments. Since

developing countries are better endowed in unskilled labor than developed countries, they will be specialized in unskilled labor intensive products during their trade liberalisation. Hence the benefit from trade liberalization will be highest for those unskilled workers (the poorest) than for skilled workers (the richest) this will lead to decreasing inequalities. Thus, according to conventional wisdom, greater openness to trade in developing countries not only increases efficiency but also reduces wage inequality. Openness boosts the relative demand for unskilled workers and hence narrows the gap in wages (and in unemployment rates) between unskilled and skilled workers.

The experience of Latin America since the mid-1980s, however, has challenged this optimistic view. Greater openness to trade has been accompanied by rising rather than falling wage inequality. In contrast, the debate over trade and inequality in *developed* countries is now over the *magnitude* of the effects, with their *direction*— adverse to unskilled workers—being largely agreed (Wood 1995).

Indeed, in a recent review of the literature on developing countries, Anderson (2005) concludes that the evidence is very mixed "Recent years have witnessed many empirical studies on the effects of openness on inequality in developing countries. On the one hand, several detailed time-series studies of individual middle income developing countries have shown that increased openness has raised the relative demand for skilled labor. On the other hand, cross-country econometric evidence suggests that increased openness has had little impact on overall inequality in developing countries. This is a puzzle, because we would expect a rise in the relative demand for skilled labor to increase overall inequality, all else being equal." This thesis addresses several aspects of this puzzle.

An important part of the recent literature on inequality and trade openness tries to explain why we do not often observe the prediction of this theory. The literature on this subject could be separated in two mainstreams: studies on aggregate inequality (mainly measured by a Gini coefficient) and studies on wage inequality (measured by a wage premium ratio).

Concerning openness and aggregate inequality, recent studies argue that we should test the impact of trade openness according to factor endowments rather than according to the level of income per capita. The reason is that for an equivalent level of income per capita, two developing countries might present differences in their factor's endowments. And the income of each person is determined by the returns of each factor which are differently distributed among the population. These studies are not always conclusive but allow obtaining an expected result concerning the endowment in human capital, e.g. that trade openness increases income inequality in relatively skilled abundant countries.

Concerning openness and wage inequality, there has been a large amount of research into the effect of openness on one particular factor price ratio, the wage of skilled relative to unskilled workers. Two hypotheses have been tested to explain why wage inequality could increase during trade liberalization. The first is that trade liberalization occurs often with a reduction in barriers to foreign investment which increases the relative demand for skilled labor by shifting the structure of production to more skill-intensive sectors, as predicted by Feenstra and Hanson (1997) and Wood (2002).The second one is that reductions in barriers to trade and investment increase the relative demand for skilled labor, by increasing the use of foreign, skill-biased, technologies by individual firms and enterprises, as predicted by Pissarides (1997).

**Thesis outline**

This thesis "Essays on Trade Liberalization and Income Inequality in Developing Countries" is in three essays.

The first chapter "Explaining Trade Flows: Traditional and New Determinants of Trade Patterns" deals with the hypothesis that countries trade according to their factor endowments: this is the factor abundance theory of Hecksher-Ohlin. This hypothesis is crucial for the link between trade and inequality. An empirical tradition in international trade seeks to establish whether the predictions of factor abundance theory match with the data. The relation between factor endowments and trade in goods (commodity version of Hecksher-Ohlin) provide mildly encouraging empirical results. But in the analysis of factor service trade and factor endowments (factor content version of HO), the results show that it performs poorly and reject strict HOV models in favor of modifications that allow for technology differences, consumer's preferences differences, increasing returns to scale or cost of trade. In this first paper we test if these "new" determinants help us to improve our estimation of trade patterns in commodities.

Since the commodity version allows obtaining a large panel data we also compare two periods, pre and post 1980. So we can evaluate if the factor abundance theory is "alive and well" in the recent trade liberalization episode relative to the past. We use a Heckman procedure to allow for non linearity in the relation between factors endowments and net exports and between trade intensity and net exports. This first part is important for the next two chapters since the conventional wisdom of trade economists concerning openness and inequality relies on the fact that factor abundance is the main determinant of trade flows between countries and inequality.

To anticipate, our results show that HOV is "alive and well" and furthermore that the "new" determinants have not more explanatory power in the period 1980-2000 compared with the period 1960-1980. Nonetheless adding the new determinants of factor content studies help us to improve the prediction of being specialized in different manufactured products. This result was already found by previous studies. That factor endowments matter is especially robust concerning specialization according to human capital endowment. This result is probably attributable to our distinguishing among three sorts of skills. Trade patterns are also determined by trade intensity, here difference in technology, trade policy, transport and transaction costs explain the difference in trade intensity. More generally, the results in this chapter provide a further justification for our concentration in the next chapter on factor endowments as factors contributing to explain why trade has different effects on income inequality.

The second chapter "Openness and Inequality in Developing Countries: A New Look at the Evidence" deals with the heterogeneity among developing countries concerning factor endowments and the fact that all factor endowments do not benefit of trade openness even when there are important in a country. Since we include all sort of factors, we use global inequality, measured by Gini coefficient, we also try to measure the trade policy rather than the rate of openness. While this approach, in considering global income, includes more than two factors production, and extends the traditional HOS model, it seems more appropriate to analyze inequality in developing countries which includes all the population. Moreover it allows including low income countries whereas they are not present in studies on wage inequality.

More precisely in this chapter we extend previous analyses that have relied only on two sorts of labor factor (skilled and unskilled) since we

distinguish between two sorts of unskilled labor, non educated and primary educated, arguing that the impact of trade openness according to human capital is a non linear relationship. Indeed, with three types of labor (no education, basic and highly skilled), Wood (1994) argues that openness in poor countries might increase inequalities by helping those with basic education and leaving even further behind those with no education. Only when the poor become reasonably skilled, can the low deciles share begin to benefit from increased labor demand. We also extend the approach on natural resources by distinguishing land resources from mineral resources which are differently distributed among the population.

The results show that trade openness raises income inequalities both for non educated abundant countries and for highly educated abundant countries. Inversely trade liberalization decreases inequality for countries well endowed in primary educated labor. These results have not been established previously. They confirm Wood (1994) framework. Our results suggest that countries with at least 20% of primary educated labor will have decreasing inequalities during their liberalization, whereas countries with at least 20% of no educated labor will have increasing inequalities. In addition, once we control for country specificity we find also that trade increase income inequalities in capital abundant countries which support the HOS model.

The policy implication is that increased openness can lead to decreasing income inequalities in developing countries if accompanied by a basic education. Workers in developing countries need to acquire a reasonable level of skill to benefit from trade liberalization.

The third chapter "Trade and Wage Inequality in Developing Countries: South-South Trade Matters" deals with wage inequality and South-South trade. Globalization does not only lead to increasing North-South (N-S) trade, the direction and composition of trade has also changed.

More trade is carried out between developing countries, and more developing countries are now exporting manufactures. South-South trade now accounts for around two fifths of all developing country merchandise trade and around 12 per cent of global merchandise trade. Trade liberalization has underpinned this development, with average tariff levels around one-third of their 1983 levels. As developing-country markets become more important for other developing countries and the future trade liberalization will mainly concern South-South trade, we need to examine closely their trade policies and their impact on inequality. First, in accounting for heterogeneity in the South we might discover that upper middle income countries are the "Northern" countries of low income countries and that this South-South trade will increase wage inequality in those middle income countries and decreasing wage inequality in low income countries.

Here it is only a transposition of the classical North-South trade theory. Second, trade liberalization with North or South could also bring inequality among workers if those who have the skills needed to adjust to the new technologies benefited from increased economic integration while the others were left behind. Here the question is how to link trade liberalization, technological change and wage inequality. Several studies link them in using the skill biased technological change. However Haskel and Slaughter (2002) showed recently that concerning USA and UK it was the sector biased technological change and not the skill biased technological change which matter to explain wage inequality. In this chapter, we adopt this approach and we explore if South-South trade and North-South impact differently on sector technological change, since this may explains a difference in the impact of South-South trade on wage inequality.

The chapter establishes several findings. First, we observe a development of a North-South trade relationship between high middle income countries

and low income countries. Since S-S trade increases competitiveness in skill intensive products, S-S trade appears to bring technological change more biased towards skill intensive sector than N-S trade.

Second increasing share of S-S trade increases wage inequality whereas North-South trade tends to decrease inter industry wage inequality. A part of this increasing wage inequality due to South-South trade comes from the development of N-S trade relationship in S-S trade which increases wage inequality in middle income developing countries (which are the North in this S-S trade). The fact that S-S trade is more skill intensive sector oriented increase wage inequality for all developing countries (included low income countries). Whereas for middle income country the impact of S-S trade on increasing wage inequality is mainly direct (through the fact that they are the North in this S-S trade) for 90%, for low income countries it is the indirect effect through the sector biased technological change which impact more on wage inequality.

# CHAPTER 1: EXPLAINING TRADE FLOWS: TRADITIONAL AND NEW DETEMINANTS OF TRADE PATTERNS


***Abstract***

An empirical tradition in international trade seeks to establish whether the predictions of factor abundance theory match with the data. The relation between factor endowments and trade in goods (commodity version of Hecksher-Ohlin) provide mildly encouraging empirical results. But in the analysis of factor service trade and factor endowments (factor content version of HO), the results show that it performs poorly and reject strict HOV models in favor of modifications that allow for technology differences, consumer's preferences differences, increasing returns to scale or cost of trade. In this paper we test if these "new" determinants help us to improve our estimation of trade patterns in commodities. Since the commodity version allows obtaining a large panel data we also compare two periods, pre and post 1980. We use a Heckman procedure to allow for non linearity in the relation between factors endowments and net exports and between trade intensity and net exports. The results show that adding the "new" determinants of factor content studies help us to improve the prediction of being specialized in the different manufactured products. However specialization according to factor endowments is stronger than ever, especially concerning the specialization according to human capital endowment. Trade patterns are also determined by trade intensity. Here differences in technology, trade policy, transport and transaction costs, explain the difference in trade intensity.



JEL Classification: F11, F14, F2
Keywords: International Trade; Hecksher-Ohlin Model

## 1. Introduction

In the neo classical general equilibrium model of international trade, countries trade with each other because of their differences. The Hecksher-Ohlin model holds on the idea that trade patterns depend on the relative differences in the factor endowment of countries. Empirical studies have often shown a weak link between factor endowment and trade flows, both within countries (between regions) and between countries. Those studies tested the two versions of the HO model[1]. In the commodity version, a capital abundant country will export a capital intensive goods and the generalization in a factor version (Vanek, 1968). In that version, a capital abundant country will export capital services. Many improvements have been tested concerning the factor content version[2], but their implications concerning net trade in commodities seems relatively weak. Predicting net trade in commodities in an nxn world is not straightforward, notably because input-output linkages preclude a linear relation between factor endowment and net exports. Furthermore, unlike in the Ricardian model, we cannot obtain a ladder of comparative advantage[3]. This paper is a contribution to the study of pattern of trade for developing countries.

So far, starting with Leamer (1984) has shown that trade specialization for primary goods is highly dependent on the differences in

[1] See Annex II

[2] There are also improvements concerning the literature about specialization in production: some authors (ex: Harrigan 1997) argue that's more important to look at the pattern of specialization rather than the pattern of trade since economists won't be able to understand trade until they understand specialization.

[3] Furthermore, because we will also studying the effect of trade on income distribution studied it is necessary.

endowments of natural resources, whereas the result for manufactured goods is not clear (even though this does not appear in his book, he developed the idea at a later date, notably in an article written in collaboration with Bowen and Sveikauskas (1987)). Subsequent attempts also encountered little success with regard to manufactured goods, the coefficients either being non-significant or carrying the wrong sign. Nevertheless, some studies (e.g. Minford (1989), Balassa and Bauwens (1988)), find that North-South trade can be explained by difference in skill endowments (but not in capital endowments).

The HOV theorem has frequently been rejected in favor of statistical hypotheses such as a zero correlation between factors' endowments and trade patterns. Facing those unclear results, the widespread view in the middle of 90's could be resumed by Leamer and Levinsohn appraisal (1995) of the empirical performance of factors endowment theories: "It is more convenient to estimate the speed of arbitrage rather than test if the arbitrage is perfect and instantaneous". Moreover, as Trefler said (1995), there is no general equilibrium model of factor service trade that is known to perform better than the HOV theorem.

Then in the middle of the 90's an expanding literature on the determinant of trade patterns used differences in consumers' preferences, in technology or in returns to scale to explain trade patterns. Differences in technology (suggested by Ricardo) have been frequently used (Trefler 1995, Davis and Weinstein 2001) and, not surprisingly, have considerably improved the prediction of trade in factor services. Difference in consumer's preferences could relate to home bias consumption (Trefler 1995) or non homothetic preferences due to differences in income per capita (Markusen 1986 or Jones and al. 1999). Finally increasing returns to scale in

some sectors is also useful to explain some factor service trade flows (Antweiler and Trefler 2002, Head and Ries 2001).

All these "new" determinants have been used in factor content studies, which have been applied mostly to developed countries because only these countries have data allowing to compute the factor content of trade in each sector in an economy. In addition to factor endowments, these studies use "new" determinants to explain why a country is a net exporter of one factor and to explain the excess of factor content in exports relatively to factor supply. Some use also these "new" determinants to explain the specialization in production (Harrigan 1997, Schott 2003).

To learn more about the determinants of comparative advantage one needs to include many countries and, if possible over a long enough period of time, to see if this determinants have changed through time. In the absence of reliable input-output data needed to compute the net factor content of trade, one way to proceed is to study the determinants of net trade on commodities (i.e. to rely on the commodity version of the HOV theorem). Lederman and Xu (2001) include these "new" determinants in a commodity version for a panel of 57 countries over 25 years for 10 products groups clusters introduced by Leamer (1984). They used a probit estimation to test the impact of factors endowments on net exports which is a better way to control for non linearity than the way used in previous studies on commodities (Leamer 1984 and 1987).

This paper extends this commodity version analysis in the following ways. First we include differences in consumers' preferences and differences in returns to scale as a determinant of comparative advantage and not only as determinants for trade intensity. Second we use total factor productivity as a measure for differences in technology, rather than expenditure in research and development. Third, our sample of 71

countries over 40 years allows us to discern two periods: pre-1980 and post-1980, and to isolate any changes in the relative importance of conventional and new factors during the period under review. Fourth we use International Trade Center (ITC) and National Asia Pacific Economic and Scientific (NAPES) commodities classification rather than Leamer's classification. This allows us to obtain better results on manufactured commodities[4]. Finally rather than use "unadjusted" factor endowments measures, we use a measure of relative factor endowment (relative to the world endowment) as in Spilimbergo and al. (1999) in order to be closer to the theory. Also we distinguish three sorts of skills.

To anticipate, our results show that HOV is "alive and well" and furthermore that the "new" determinants have not more explanatory power in the period 1980-2000 compared with the period 1960-1980. Nonetheless adding the new determinants of factor content studies help us to improve the prediction of being specialized in different manufactured products. This result was already found by previous studies. That factor endowment matter is especially robust concerning specialization according to human capital endowment. This result is probably attributable to our distinguishing among three sorts of skills. Trade patterns are also determined by trade intensity, here difference in technology, trade policy, transport and transaction costs explain the difference in trade intensity. More generally, the results in this chapter provide a further justification for our concentration in the next chapter on factor endowments as factors contributing to explain why trade have different effects on income inequality.

The paper is organized as follows. Section 2 reviews the presentation of the HO model and the amendments added in the factor

[4] The manufactured commodities' clusters are more detailed.

content studies. Section 3 describes the empirical approach, the data used and their organization between explanatory variables for comparative advantage and for trade intensity as well as the cluster's construction. Section 4 presents the econometric results and section 5 concludes.

## 2. Approaches to explain trade patterns

This section presents the framework and justifies the empirical approach. Consider the standard Hecksher-Ohlin theory, with a world of $C$ countries $(c = 1,....,C)$, $I$ industries $(i = 1,....,I)$ and $F$ factors $(f = 1,....,F)$. Let $Y^c$ $(I \times 1)$ the output in country $c$. The factor content of $Y^c$ is $AY^c$, where $A$ is a matrix $(F \times I)$ of factor content coefficient. Let $V^c$ the factor endowment of country $c$, the full employment implies that $AY^c = V^c$. For the world we get: $AY^w = V^w$, assuming that factor intensity (technology) $A$ is identical in each country for each good and the assumption that the technology is identical assumes that the factor price equalization holds in equilibrium.

If we assume that each country consumes the product in the same proportion (identical homothetic preferences) we have: $C^c = s^c Y^w$ where $s^c$ is the country's consumption share: $s^c = pC^c / pC^w$ where $p$ is the vector of internal prices. Under balanced trade, the vector of net exports $T^c$ is the difference between production and consumption

$$T^c = Y^c - C^c = A^{-1}\left(V^c - s^c V^w\right) \qquad (1.1)$$

The link between factor prices and commodity prices is implied by the zero profit conditions, where $w$ is the vector of factor returns: $Aw = p$. Here equation *1.1* says that trade in each industry is linearly related to factor endowments.

In higher dimensions it becomes impossible to state the HO theorem in a useful way analogous to its statement in the 2 –dimensional case. What remains true in higher dimensions is that the inverse of a strictly positive matrix has at least one positive and at least one negative element in every row and column (Either 1974). So each factor has at least one friend and at least one enemy among goods. But we have to assume here that $A$ is invertible (it is square with $I = F$ ). That is why Vanek rephrased the HO theorem in a correct way, which is called the factor content version (in contrast to the commodity version). A country with balanced trade will export the services of abundant factors and import the services of scarce factors. This equation does not depend on any assumptions about the dimension or invertibility of the matrix $A$ .

$$F^c = AT^c = \left(V^c - s^c V^w\right) \qquad (1.2)$$

### *2.1 Empirical approach to "test" the theorem*

The three main approaches used to assess the HO theorem are presented in table 1. Column 2 describes the basic approach, column 3 extensions to that approach, column 4 the estimation technique and column 5 the results.

The first (Table 1a), uses the factor content version (equation 1.2) and directly link net trade in factor services and factor endowments. In order to do that, authors use an input-output matrix by sector to measure the factor intensity in each sector[5] and then, knowing the net exports of each sector, they can calculate the net exports of factors.

$$F^c = AT^c = \left(V^c - s^c V^w\right) \qquad (1.2)$$

[5] except Antweiler and Trefler (2002)

This approach is undeniably the most appropriate technique to test the HOV proposition, since all parameters are measured, none are estimated econometrically. However it requires data that are not available for a large number of countries and for many years (as input-output data). Therefore those analyses have only appeared relatively recently and are always imperfect. They often cover just one year (Bowen and al., 1987, Trefler, 1995, Davis and Weinstein, 2001, Schott, 2003), or do not use real input output matrix from all countries[6] (Bowen and al. 1987, Trefler 1995, Estervadeordal and Taylor 2002), or do not account for natural resources (Davis and Weinstein). These misspecifications (e.g. imposing the same input-output matrix for all countries) lead some authors like Estervadeordal and Taylor (2002) to "give HO a break"; that is, to argue that one should stop the test on factor content until reliable and sufficient data becomes available for a large panel of countries for a long time period. However those studies provide interesting improvements that are useful for other forms of the HO test. Notably, they have relaxed some central assumptions from the HO model (similarity in technology and consumer preferences, constant returns to scale and no trade impediments) to obtain "new" determinants. These so called "new" determinants improve the explanation of trade patterns. Not surprisingly, generally, they find that a strict HO model (just considering difference in factor endowments) performs poorly.

**Table 1a: Studies of factor content in trade**

| **Authors/Sample** | Factors | Extensions | Empirical Technique | Results |
|---|---|---|---|---|
| **Bowen, Leamer Sveikauskas 1987** 27 countries in 1967 | K, 3 sorts of land, 7 sorts of labor | Technological difference in using US I-O matrix Non proportional consumption | Proportion of factors for which the sign of net trade in factor matched the sign of the corresponding supply in factor | Sign test[7]: no supportive, the role of technological is not clear. |

[6] They use the US input –output matrix

[7] Sign test focuses on whether the sign of net trade in factor (left hand-side in equation 2) matches the sign of excess supply in factors (right hand-sign in equation 2).

| | | | | |
|---|---|---|---|---|
| **Trefler 1995**<br>33 countries in 1983 | K, 2 sorts of land, 7 sorts of labor | Technological difference in using US I-O matrix<br>Home bias in consumption | Compare for nine factors the difference in endowment to the net trade (factor content test). Then add neutral technology difference and Armington home bias in consumption | Sign test and variance ratio test[8]: supportive if we allow for neutral technological difference and home bias in consumption |
| **Davis and Weinstein 2001**<br>10 countries and the ROW (20 countries aggregated) in 1985 | K and Labor | Technological difference in using I-O matrix for all 10 countries<br>Trade impediments<br>Non homothetic preferences | Estimate with identical technology (US), then with Hicks neutral difference and no Hicks neutral difference. And finally with trade cost and non homothetic preferences | Sign test and variance ratio test: supportive if we allow for technological difference and costs of trade |
| **Antweiler and Trefler 2002**<br>71 countries on 1972, 1977, 1982, 1987, 1992 | K, 3 sorts of land, 4 sorts of educational level, 3 sorts of energy stocks | Technological difference (by difference in wages)<br>Increasing scale returns | Estimation of the scale economies in each sector then use to explain net trade in factors. | For sector with increasing returns to scale, scale economies contribute to understand the factor content of trade. It doesn't improve the sign test. |
| **Estervardeorval and Taylor 2002**<br>18 countries in 1913 | K, Land, 2 sorts of educational levels | | Compare the difference in factors endowment to the net trade in factor in using the same US I-O matrix for all countries | Sign test and variance ratio test: no reliable<br>Some goods results for natural resources but not for K and L. |

A second approach (Table 1b) consists in studying the patterns of industrial specialization. Some authors prefer to test comparative advantage by specialization in production reasoning that economists won't be able to understand trade until they understand specialization. These studies test if production by commodities' clusters conforms to comparative advantage in factors endowments.

$$Y^c = A^{-1}\left(V^c - V^w\right) \qquad (1.3)$$

With this approach they avoid all problems due to trade impediments or differences in consumer's preferences. Commodity clusters are constructed according to factor intensity in each product. The studies often relax the assumption of identical technology to obtain better results. Nevertheless when they use the strict HOV model, this approach yields results that are more in conformity with the prediction than the factor content studies.

[8] Variance ratio test ask whether the variance of net trade in factor is as large as variance of excess supply in factors.

However this empirical method is far away enough from the Hecksher-Ohlin theorem which is based on international trade and data on production by sector is less available than data on trade by sector, so the sample of countries is often small.

**Table 1b: Studies of patterns of specialization**

| **Authors** Sample | Factors | Extensions | Empirical Technique | Results |
|---|---|---|---|---|
| **Harrigan 1997** 10 countries on 1970-1990 | K, Land, 3 sorts of educational levels | Technological difference in using I-O matrix for all countries | Compare the share of production on GDP of each commodities cluster to the factors endowment and TFP in each sector. | Technological differences as well as factors endowment difference give comparative advantage. |
| **Harrigan and Zarajsek 2002** 28 countries on 1970-1992 | K, Land, 2 sorts of educational levels | | Compare the share of production on GDP of each commodities cluster to the factors endowment. | HO performs particularly in large industrial sectors that are not natural resource-based. |
| **Schott 2003** 45 countries in 1990 | K, Land, 2 sorts of educational levels | Difference in capital intensity within industry (across countries) | Construct new goods aggregate for each country according to the factor intensity difference within industry across countries | Once we account for intra industry trade due to difference in capital intensity, the HO model performs. |

Like the first approach, the third approach analyzes the patterns of trade that are linked to factor endowments. This third approach (Table 1c), which we choose in this paper, is to compare factor endowments and trade in commodities as in equation 1.1.

$$T^c = A^{-1}\left(V^c - s^c V^w\right) \qquad (1.1)$$

It was first developed by Leamer (1984) for two years, 1968 and 1975. One objective of such an estimation exercise is to infer implicitly the value of $A^{-1}$ (that is not directly measured) and to study how it changes over time. As for the commodities specialization test, this approach demands us to construct commodity clusters, which regroup products sharing the same technology.

In this paper we construct clusters differently than those used in previous studies to be more precise. This approach presents advantages

because we only need data on endowment and trade, and not on technology in each product. Less data requirements makes it easier to carry out the analyses on a long time period (e.g. Lederman and Xu 2001). Because it does not make reference to factor intensity, it is a weakened form of the HOV model, what Feenstra (2004) calls the "partial" test. Curiously, this approach rarely relaxes assumptions of the HO model, except for Lederman and Xu (2001). Finally this type of approach allows us to obtain a large sample which is best to compare the role of endowment in factors and "new" determinants in explaining trade patterns.

**Table 1c: Studies of net export patterns**

| **Authors** Sample | Factors | Improvements | Empirical Technique | Results |
|---|---|---|---|---|
| **Leamer 1984** 27 countries 1958 and 1975 | K, 3 sorts of land, 7 sorts of labor | | Net exports by commodities clusters on relative factor's endowments | Perform for natural resources intensive commodities |
| **Eastevardeorval 1997** 18 countries in 1913 | K, 2 sorts of Land, 2 sorts of educational levels | | Net exports by commodities clusters on relative factor's endowment | HO performs concerning the significance of relationship between factor endowment and net trade of goods. |
| **Lederman and Xu 2001** 57 countries on 1970-1995 | K, 3 sorts of land, 2 sorts of educational levels | Difference in research and development<br>Scale economics<br>Consumers preferences<br>Non linearity<br>Trade impediments | Probability of being a net export for different commodities clusters on factors endowment, knowledge, ICT. And in a second step trade intensity for net importers and net exporters on scale effects or consumers preferences. | Land and capital play an important role on determining the status, but also other characteristics |

### *2.2 Extensions to the strict HO theorem*

As we have just seen, many assumptions on the HO theorem have been relaxed in previous studies. Let us look closely the theoretical implications of such relaxations. The HOV relation holds under the following: homogeneity in technology, constant scale returns, homothetic consumers' preferences, non trade impediments. Otherwise, the relation between factors endowments and net export is not linear since it depends on the

hypotheses that are relaxed. Which assumptions are relaxed in our study are discussed below.

**Differences in technology**: Factor content studies have shown us that similarity in technology is an assumption of the HOV model that must be relaxed to have a convenient test (Trefler 1995, Harrigan 1997, Davis and Weinstein 2001). Input output analyses among sectors between countries (Davis and Wenstein 2001, Schott 2003) have shown that factor intensity in sector varies across countries. This difference in technology could influence trade patterns in two ways. Firstly, concerning a neutral technology difference, it captures efficiency in the use of inputs, hence two countries with similar factors endowments but different inputs' efficiency could have different patterns of trade[9]. Secondly, concerning a technology difference that changes factor proportion in sectors, it could provide a competitive advantage in the production of some specific goods[10]. Hence, let $\delta_c$ measure the difference in factor productivity of each country. Compared to the standard $A^{-1}$ (equation 1.3a), we obtain a new equation for net trade in commodities (equation 1.3b).

$$Y^c = A^{-1}\delta^c V^c \qquad (1.3a)$$

$$T^c = A^{-1}\left(\delta^c V^c - s^c V^w\right) \quad (1.3b)$$

The impact of this difference in technology for specialization has been rarely tested empirically. Bowen and al. (1987) modify the HOV model by introducing differences in technology. And if they find that the original HOV model has a weak prediction, they reject as well differences in technology as a determinant. However, subsequently Trefler (1995) has shown that a model taking into account differences in technology between

[9] In Trefler (1995), his preferred model use neutral technology difference across industries or factors which does not influence comparative advantage, so differences in technology are pure scale effects.

[10] Neary (2003) using graphics shows that comparative advantage (determined by factors endowments) always explains trade structure. However, competitive advantage (in terms of productivity) has an impact on resource allocation, structure and volume of trade.

developed countries and developing countries improves substantially the empirical results of the original HOV model. On the other hand, in studies using the same test as we use in this paper (the weakness test), the difference in technology is never relaxed, except in the Lederman and Xu (2001), which controls for cross-country technological heterogeneity via unconvincing measures (research and development expenditures and stock of technical workers). Here we take into account differences in productivity via total factor productivity.

**Homothetic preferences:** Homothetic preferences in consumption also need to be relaxed. Hunter and Markusen (1988) provide convincing evidence that an assumption of quasi-homothetic preferences is superior to the traditional assumption of homotheticity. Bowen and al. (1987) find no evidence to relax such a restriction, but Markusen (1986) and Davis and Weinstein (2001) improve their factor content studies in considering non homothetic preferences. That is why in our study we include the mean income per capita[11] as we consider an expanded version of the HO model by allowing a portion of consumption to be dependent on income (equation 1.4a). Under this more general formulation, if the endowment among two countries do not differ by much but demand patterns differ by more, a capital intensive country may export its relatively labor intensive commodities if its tastes are biased towards those commodities produced with more capital intensive techniques (equation 1.4b).

$$C = C_{(Y/L)} \text{ so } s^c = s^c_{(Y_c/L_c)} \qquad (1.4a)$$

$$T^c = A^{-1}\left(\delta^c V^c - s^c_{(Y_c/L_c)} V^w\right) \qquad (1.4b)$$

[11] Jones and al. (1998) explained clearly that in the case of intra-sectoral trade. A capital abundant country may import a more capital intensive good than this exported. Effectively whereas the traditional inter-sectoral factor intensity basis for trade relies primarily on supply-side differences between country in their endowments, the intra-sectoral pattern of trade reflect demand side differences

**Returns to scale**: The assumption of constant returns to scale should also be relaxed. Returns to scale are not constant across sectors. Large countries have low autarkic price in sectors where scale economies are important (with increasing returns). Therefore, these countries have a comparative advantage in the international market for specific sectors with increasing returns to scale. Markusen and Melvin (1981) develop a model where in equilibrium a large country exports the commodity with increasing returns to scale and the other countries export the commodities with constant returns to scale. Antweiler and Trefler (2002) in a factor content version find that allowing for the presence of increasing returns to scale in production significantly increases our ability to predict international factor services trade flows. They find that a third of all goods-producing industries are characterized by increasing returns to scale[12]. Since scale likely includes aspects of international technology differences[13], it is important to use a measure which is not directly related to factor productivity. Here we adopt the Lederman and Xu (2001) technique of adding as determinant of trade patterns a measure of scale in the economy (population) to see which sort of products are sensible to increasing returns to scale[14]. We use the formulation of Antweiler and Trefler (2002) where $\mu$ is the elasticity of scale in each sectors (equation 1.5a). Contrary to technological differences which are specific to each country, increasing scale returns are specific to sectors.

$$T^c(\mu) = A^{-1}\left(\delta^c V^c - s^c_{(Y_c/L_c)} V^w\right) \qquad (1.5a)$$

[12] These increasing returns to scale factors content prediction have rarely been explored empirically. Leamer (1984) admits that it is "a great disappointment" that his work does not deal seriously with economies of scale

[13] In Antweiler and Trefler (2002), the industries with the largest scale estimates are mostly those where technical change has been most rapid. New process technologies are often embodied in larger plants.

[14] Trefler (2002) remarked, it seems unusual that we do not distinguish between internal and external returns to scale, as their different in their implications for market structure and trade patterns. But Helpman and Krugman (1985) help us in showing that the form of scale has only very modest implications for the factor content of trade.

**Trade impediments**: Frictions (trade barriers[15], transaction and transport costs) should also be taken into account. As Leamer (1984) showed, these impediments are reflected in a deviation of domestic prices from international prices. Davis and Weinstein (2001) improve the HOV model in adding a measure of trade costs through a gravity equation. We control for landlockness and distance to the market[16], which could increase transport costs. We also control for the difference in infrastructure and ICT endowment, and we take into account the intensity of free trade by using a measure of deviation from predicted trade, to measure trade barriers. We introduce the price differences notion in our formulation: let $\theta$, the price difference to the world price due to transport cost, tariffs and other trade impediments. We express trade and resources in value terms.

In matrix notation, let $\theta$ subscript indicate variables that depend on trade impediments, $w$ the vector of factor prices and $p$ the vector of commodity prices. Then, the zero profit condition $Aw = p$ becomes $A_\theta w_\theta = \theta p^w = p_\theta$. Hence, the production evaluated at the internal prices is $Y^c = A^{-1} w_\theta V^c$ and the consumption at internal prices is $C^c = s_\theta^c Y^w$. Let $w_\theta V^c$, be the vector of resources evaluated at the internal prices, and $w_w V^w$, the vector of world resources evaluated at the world prices. We may then write the trade vector in value terms as:

$$p_\theta T^c(\mu) = A_\theta^{-1}\left(w_\theta \delta^c V^c - s^c_{\theta(Y_c/L_c)} w_w V^w\right) \qquad (1.6)$$

[15] Travis (1964) argues that tariffs on labor intensive imports can explain the Leontief finding that US in 1947 was net exporter of labor services.
[16] Distance to the ten main partners in trade.

## 3. Empirical approach

This part presents econometric results about the determinants of trade structure and trade intensity across countries and over time. These estimates control for the simultaneous determination of the intensity of trade (that is, the level of net exports) together with a non-linear version of comparative advantage models. More specifically, we model export intensity as a Heckman selection model. That is, country-specific characteristics or factor endowments determine comparative advantage (proxied by the condition of having positive net exports), and then domestic and foreign market sizes, the macroeconomic environment, transaction costs, and institutions determine export intensity. Moreover, we allow the estimates of trade intensity for the net-importer and the net-exporter sub-samples to differ.

### *3.1 A selection model*

To implement equation (1.6) one could regress the net exports of a country $c$ for a product $i$ in year $t$, $NX_{ict}$, on endowment in different factors $j$, $E_{jct}$, on $k$ new determinants (difference in productivity, in consumers preferences and returns to scale) $N_{kct}$, on $m$ variables determining trade intensity (or impediments) $TI_{mct}$ and on regional dummies $DR_{rt}$ and year dummies $DY_t$ in the following way:

$$NX_{ict} = \beta_0 + \sum_{j=1,5} \beta_{1j} E_{jct} + \sum_{k=1,3} \beta_{2k} N_{kct} + \sum_{m=1,5} \beta_{3M} TI_{mct} + DR_{rt} + DY_t + \varepsilon_{ct} \qquad (2.1)$$

However trade impediments variables will not have the same impact on net trade for net importers and net exporters, since trade liberalization increases the net trade ratio for net importers and decreases

the net trade ratio for net exporters. So in a linear homogenous implementation, the effects of many variables are washed out by this heterogeneity. In other words, it is unlikely that the coefficients of the explanatory variables for trade intensity are the same for all countries, especially for importing and exporting countries of the same commodity. If we consider that the impact of trade intensity differs according to the status for a country (e.g. increase (decrease) net exports for net exporter (net importer), we have to add the trade intensity variables interacted with a dummy indicating the status $S_{ct}$ of the country (where 1 indicate a net exporter and 0 a net importer). And the status of countries, net exporter or net importer, depends mainly on factors endowments but also on technology, consumers' preferences and scale effects.

However once we account for the status, factor endowments does not matter on the volume of trade $NX_{ict}$. Neary (2003) shows that comparative advantage in factors endowments continues to determine direction of trade (the specialization) however competitive and absolute advantage due to productivity or scale effects impact on trade patterns and trade volume. So factors endowments do not appear in our second step on net trade volume; they impact only on the status. An estimable model would have the following form:

$$NX_{ict} = \beta_0 + \sum_{k=1,3} \beta_{1k} N_{kct} + \sum_{m=1,5} \beta_{2M} (S_{ct} * TI_{mct}) + \sum_{m=1,5} \beta_{3M} TI_{mct} + \beta_{4M} S_{ct} + DY_t + \varepsilon_{ct} \quad (2.2)$$

$$\text{where } S_{ct} = \alpha_0 + \sum_{j=1,5} \alpha_{1j} E_{jct} + \sum_{k=1,3} \alpha_{2k} N_{kct} + DR_{rt} + DY_t + \mu_{ct} \quad (2.3)$$

$$\text{with } \beta_2 > 0 \text{ and } \beta_3 < 0$$

But in using a probit estimation for the status, this implies that the relationship between factor endowment and the net export is not linear. The initial presumed linear relationship between factor endowments and

the structure of net exports is questionable (Leamer 1984, Leamer et Levinsohn 1995). Effectively all countries do not produce all goods, particularly developing countries. An increase in capital endowment would not lead to an increase in capital-intensive good exports if the country is already specialized in a non capital intensive good or does not product a capital intensive.

As Leamer (1995), we present our data in Figure 1 below which plots net exports of a labor-intensive aggregate composed mostly of apparel and footwear divided by the country's workforce against the country's overall capital/labor ratio. There is very clear evidence of nonlinearity here – countries which are very scarce in capital don't engage in much trade in these products. Exports start to emerge when the capital/labor abundance ratio is around $10,000 per worker.

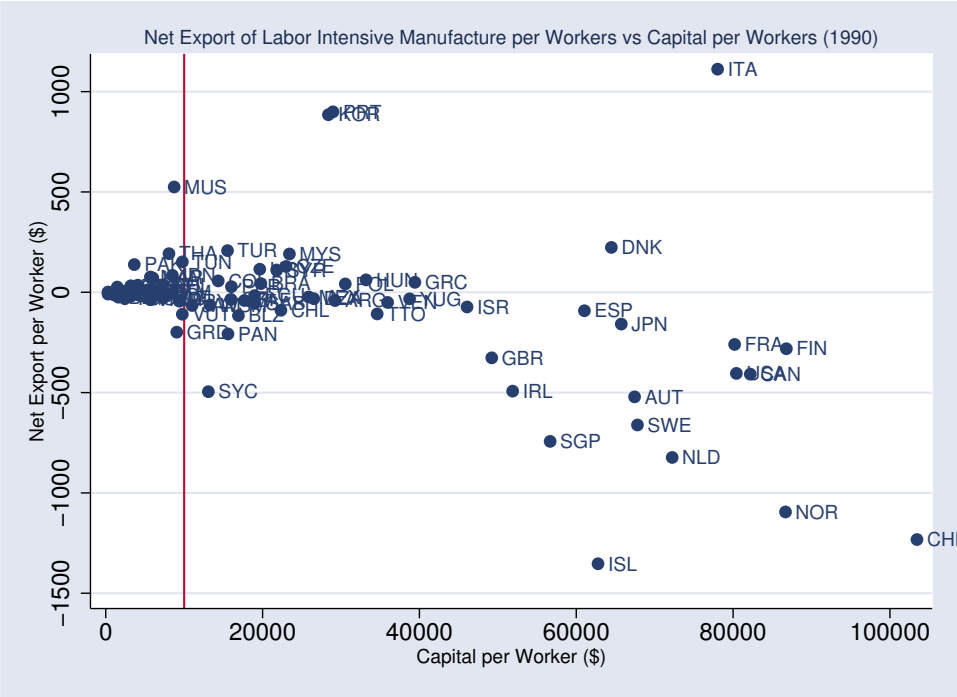


Figure 1

Exports rise to around $300 per worker when the country's abundance ratio is around $20,000 per worker. Thereafter, net exports

steadily decline, turning negative when the country's capital/labor abundance ratio is around $40,000. Hence until a sufficient level of capital per worker, an increase in capital per worker has no effect on specialization.

With a probit estimation we have a non linear relationship, meaning that the marginal impact of an increase in factor endowment is greater when the factor endowment is sufficiently high to allow countries to be specialized in the good. So we are confident in our assumption concerning non linearity between factor endowment and trade structure.

With a linear estimation, we would have biased results in case of correlation between $\varepsilon_{ct}$ and $\mu_{ct}$. It is plausible that the unobservable variables for the status would be correlated with unobservable variables for the amount of net exports. Following Lederman and Xu (2001), we use a Heckman procedure to control for that. As shown in Figure 2, we initially test in equation *2.4* the probability of being a net exporter of a good (i.e. the status). We assume that the probability of having positive net exports $S_{ct}$ is determined by the conventional explanatory variables, factor endowments $E_{jct}$ (arrow 1), and by 'new" determinants $N_{kct}$ (arrow 2). Contrary to Lederman and Xu (2001), we assume increasing returns to scale and differences in consumers' preferences as potentials determinants in this comparative advantage equation. Moreover some determinants of trade intensity $TI_{mct}$ (e.g. infrastructure and ICT) could also determine comparative advantage (arrow 3), since products are differently sensitive to transport and transactions costs[17].

[17] In a Heckman procedure all determinants of the second step (here trade intensity variables) have to be included in the first step if they are significant in this first step. The same variables that determine how big a country's net exports of a particular good (or commodity group) also determine that probability that a country will export these goods at all.

$$S_{ct} = \alpha_0 + \sum_{j=1,5} \alpha_{1j} E_{jct} + \sum_{k=1,3} \alpha_{2k} N_{kct} + \sum_{m=1,2} \alpha_{3m} TI_{mct} + DR_{rt} + DY_t + \mu_{ct} \qquad (2.4)$$

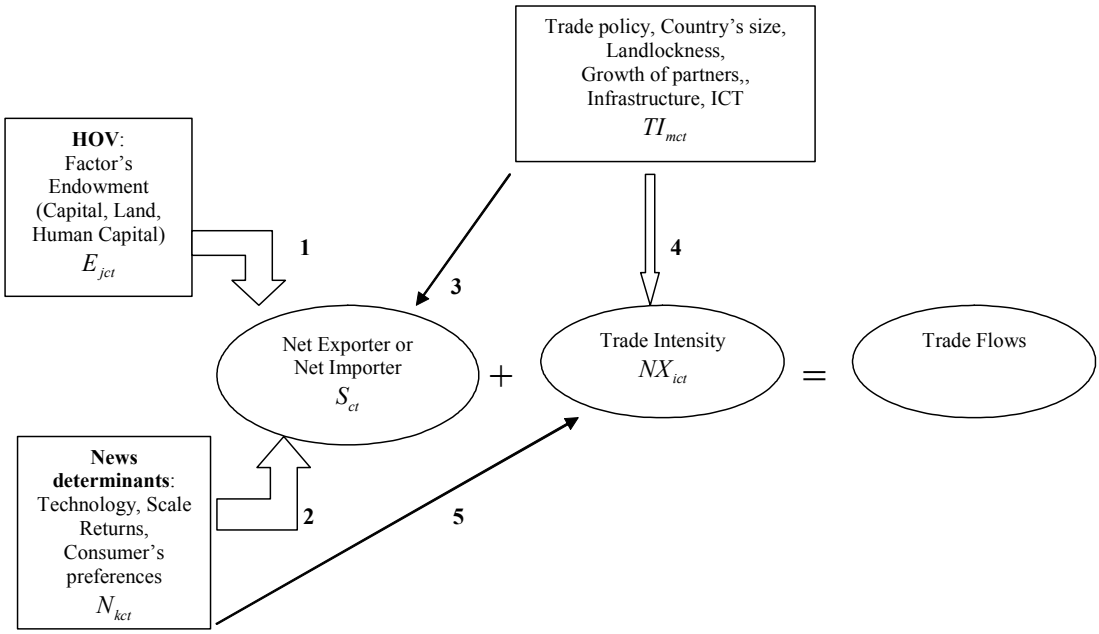


Figure 2

Then we continue by testing the explanatory variables on the samples of net exporters (equation *2.5*) and net importers (equation *2.6*) relative to trade intensity (Figure 2). To the usual determinant of trade intensity (arrow 4), we add new determinants that are as important as in comparative advantage (arrow 5). This procedure permits to uncover a trade intensity trend, since, without separating the sample into net importers and net exporters, it cannot appear. Effectively an increase in trade will raise net exports in the net exporters segment and the net imports in the net importers segment, therefore on a global sample the effect on net export would be null.

$$NX_{ict} = \beta_0 + \sum_{k=1,3} \beta_{1k} N_{kct} + \sum_{m=1,5} \beta_{2M} TI_{mct} + DY_t + \varepsilon_{ct} \text{ if S=1} \qquad (2.5)$$

$$NX_{ict} = \beta_0 + \sum_{k=1,3} \beta_{1k} N_{kct} + \sum_{m=1,5} \beta_{2M} TI_{mct} + DY_t + \varepsilon_{ct} \text{ if S=0} \qquad (2.6)$$

This specification is acceptable only if we add variables in the first step that do not appear in the second step to identify our model. Those variables are factor endowments and regional dummies. Our justification is both theoretical and statistical. Firstly as we said before, we do not expect a linear relation between relative factor endowment and net export intensity[18]. Secondly, from a statistical standpoint, we see in the Table A1 (in Annex) that the condition of being a net exporter has an even higher cross-country variance (column "between") relative to cross-time variance (column "within") than the value of net export for most sectors. The relative factor endowment variables (in bold) are also relatively more stable over time than among countries.

### *3.2 Construction and measure for commodities' clusters*

In order to divide the products into different categories (Table 2), we drew our inspiration from Leamer (1984) whose classification is often used in other studies (Estervadeordal 1997, Lederman and Xu 2001) from the NAPES' classification and from the factor intensity classification of Marrewjik (2004) on the basis of UNCTAD/WTO and ITC classification. Our classification (Table 3) is less detailed than Leamer's with regard to the categories of primary products for which the determinants of comparative advantage have often been estimated. We construct three clusters of primary products, agricultural products (AGR), processed food products (PFO) and Minerals products (MIN).

We increase the number of categories of manufactured goods by using a 3-digit classification, in order to distinguish human capital intensive products, which was not allowed in Leamer's classification. We obtain five clusters for manufactured products: intensive in natural resources and capital (NRK), intensive in unskilled labor (UNL), intensive in skilled labor

[18] When we add factor endowment ratios in the second equation we obtain non significant or non sensible results.

(SKL), intensive in capital (CAP) and intensive in technology (TEC). This level of detail is more precise compared to the existing literature; which should allow us to obtain better results than using only a two digit classification.

**Table 2: Construction of clusters**

| NAPES | Sitc Rev.2 | Leamer | Sitc Rev.2 | Marrewjick | Sitc Rev.2 | Our Clusters | Sitc Rev.2 |
|---|---|---|---|---|---|---|---|
| **Agriculture** | 00, 041-045, 051, 052, 054, , 2-27- 28 | **Forest, Tropical, Cereals Animal Products** | 0,1, 2-27- 28 63,64 | **Primary** | 0, 1, 2,,3 ,4 | **Agriculture (AGR)** | 00, 041-045, 051, 052, 054, 2-27-28 |
| **Processed Food** | 01, 02, 03, 046-048, 053, 055, 06,07, 08, 09, 1, 4 | | | | | **Processed Food (PFO)** | 01, 02, 03, 046-048, 053, 055, 06,07, 08, 09, 1, 4 |
| **Minerals Intensive** | 27, 28, 3,61,63, 661-663, 667, 671, 68 | **Raw Materials** | 27, 28, 3-33 68 | | | **Minerals (MIN)** | 27, 28, 3-33 |
| | | | | **Natural resources** | 61, 63 661-663, 667, 671, 68 | **Natural resources (NRK)** | 61, 63, ,661-663, 667, 671, 68 |
| **Labour intensive** | 65, 664-666, 81-85, 894, 895, 899 | **Labour intensive** | 66, 82-85, 89 | **Unskilled Labour** | 65, 664-666, 793, 81-85, 894, 895 | **Unskilled Labour (UNL)** | 65, 664-666, 81-85, 894, 895 |
| | | | | **Human capital intensive** | 53, 55, 62, 64, 67(-671), 69, 76(-764), 78, 791, 885, 892, 896, 897, 898 | **Skilled Labour* (SKL)** | 52,53, 55, 59, 896, 897, 899 |
| **Capital intensive** | 5, 62, 64, 67, 69, 7, 87, 88,, 892, 896, 897, 891, 893 | **Capital intensive** | 61, 62, 65, 67, 69, 81 | | | **Capital intensive (CAP)** | 62, 64,67, 69, 76(-764), 78, 791,891, 892, 893 |
| | | **Chemicals** | 5 | **Technology intensive** | 51, 52, 54, 56-58,59, 71,72,73, 74, 75 , 764, 77, 792, 87, 881-884, 893 | **Technology intensive (TEC)** | 51, 54, 56-58, 71,72,73, 74, 75 , 764, 77, 792, 87, 88 |
| | | **Machinery** | 7, 87, 88 | | | | |

*We use Marrewijck(2004) and Estervadeordal (1997) approach for this cluster.

Because of the incertitude on the form of the relationship between factor endowments and trade structure (linear or not), I used several specifications to measure trade structure. Sometimes gross exports are used. Deardoff (1984) clearly prefers to use the net exports indicator, arguing that if there are differences with gross exports results, it will be due to intra industry trade about which H-O theorem does not reach a decision. We follow Leamer (1988) approach and for selected clusters, we use the share of net exports on GDP. This ratio being negative for net importers, we added a constant to allow us to use a logarithm form. We finally obtain a sample of 71 countries on 1960-2000.

### *3.3 Construction and measure for factors endowments*

The HO model framework considers relative factor endowment between many factors but also between many countries. Factor intensity in a country is often measured as factor intensity in a sector, i.e. by a ratio of the factor on labor as denominator for the most reliable studies; otherwise some only use the stock of the factor. It is more suitable to use a ratio of per capita endowment of a factor in the country to the world per capita endowment of this factor as we deal with relative advantage in factor endowment (Harrigan and Zakrajsek, 2002). We use the formula constructed by Spilimbergo and al. (1999)[19]. The ratios are weighted by the degree of openness to take into account that endowments of closed countries do not compete in the world markets with other factors.

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[19] $E_{if}$ is the endowment of country *i* in factor $f$ and the measure of relative endowment is

$$RE_{if} = \ln \frac{\left(E_{if}\right)}{\left(E_f^*\right)} \text{ and } E_f^* = \frac{\sum_i \left( E_{if} \times pop_i \times \left( \frac{X+M}{GDP} \right)_i \right)}{\sum_i \left( pop_i \times \left( \frac{X+M}{GDP} \right)_i \right)}$$

The factor content studies mainly used occupational-based classification to measure human capital endowments. We prefer to use an educational-based classification for the reasons exposed by Harrigan (1997). The first is that educational levels are more likely to be exogenous with respect to net exports shares, since growth in some industries might induce workers to shift their occupations. The second is that education is probably more closely related to skill than occupation. However, rather than using a secondary school enrolment rate (lagged six years) as Balassa and Bauwens (1986) did, we prefer to use as Harrigan and Zakrasejk (2000), stock measures of education of the current labor force calculated from the Barro and Lee database (2000). In contrast to Estervadeordal (1997) or Schott (2003) who used only the distinction between skilled and unskilled workers, we use, as Harrigan (1997) three sorts of skill: unskilled, primary skilled and highly skilled.

Physical capital is difficult to include because of its mobility. Wood (1994) argues that empirical tests of the H-O model were mispecified by considering physical capital as the land while it is more mobile across countries and should not affect the structure of net exports across countries. However, the well-known Ethier-Svensson-Gaisford (ESG) model with mobile (capital) and immobile (land and labor) factors shows that capital is a determinant of pattern of trade for a country, depending on capital intensity of the goods in which its immobile factors give it a comparative advantage. Thus if a country has a high labor-land ratio, making it an exporter of clothing, which happens to be also capital intensive, then it exports capital via goods and capital affects the pattern of trade. But if it has a low labor-land ratio, making it an exporter a less capital-intensive goods (e.g. food), then it exports capital directly (by Foreign Direct Investment). Following Leamer (1999), we adopt the Kraay and al. (1999) measure of capital stock per worker.

The measure for natural resources is arable land per habitant, so our measure does not include resources in mineral and fuel which are not available for a large sample in the period under review. The only measure available for our sample is the index from Isham and al. (2005) based on the net export ratio in mining and fuel products, so we could not use it in an estimation of net exports in mineral products due to endogeneity issues.

### *3.4 Construction and measure of "new" determinants of trade*

Concerning differences in technology, we measure total factor productivity (TFP). This measure was used by Harrigan (1997) to explain how differences in technology associated to factor endowments could help to explain specialization in production. We use the TFP index of Bosworth and Collins (2003) who calculate the residual of a growth regression (assuming constant returns to scale). We use a proxy of scale economic effect that could lead the country to be specialized in some increasing returns to scale sectors, measured by the number of habitants. We control also for differences in consumer's preferences via income per habitant, since an increase of per capita income will lead the consumer to prefer capital and human intensive goods and hence to be a net importer of this commodity.

### *3.5 Construction and measure of trade intensity explanatory variables*

Variables that determine trade intensity can be separated in two groups: structural variables and the political variables. The first ones are the distance to its main partners, and the size of the domestic market, which is measured by population and GDP per habitant. Domestic transport infrastructure and transaction costs determine the amount that a country exports or imports. For those variables, we use an index constructed as a principal component (roads networks, rails networks and

paved road for infrastructure; personal computer, internet host, telephone lines and mobile phones for ICT). Finally openness depends on the degree of outwardness for the country. We measure this position by an indicator computed from the method proposed by Guillaumont (1994). We measure the part of trade that is not explained by domestic market size (population), landlockness, mean income in the country, to be an OCDE country and to be an oil exporter[20]. Since we use generated variables (openness policy, mills ratio, principal component index) we have to recalculate all the standards errors of the variables, we use the bootstrap technique to estimate standard errors and to construct confidence intervals[21].

## 4 Results

The main objective of this study is to improve the prediction of patterns of trade. So we have to assess the reliability of the prediction of status for each country. This is done in section 3.1. We have also a large part of this paper on the importance of "new" determinants of comparative advantage. In section 3.2, using an Anova estimate, we compare their importance relative to the traditional factors and we analyze changes during two periods, 1960-1980 and 1980-2000. Then we comment on the results of the Heckman estimation. In section 3.3 we present results for the first step, the selection equation on comparative advantage, which is estimated for two periods. The last section, 3.4, deals with the second step, trade intensity. We jointly comment results on net exporter and on net importer of each cluster.

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[20] $\ln\left(\frac{X+M}{PIB}\right) = 11.68 + 0.09^{**} \ln(PIB/t) - 0.25^{***} \ln(Pop) - 0.50^{***} \ln(Dist) - 0.05(encl) + 0.07^{***} \ln(Xpétrole) + \varepsilon$

[21] For a generated variable, the confidence interval in the second step is not correct as it refers to the first step. So we built a sampling distribution based on the initial sample from which repeated sample are drawn to obtain a correct distribution and correct standards errors.

### *4.1 Goodness of fit*

A way to assess model fit is to concentrate on its predictive power by looking at prediction statistics. In the first part of table 4 we present the goodness of fit for a model with only factor endowments. In the second part, we add new factors (productivity differences, scale returns and consumers preferences) and in the last part we add ICT and infrastructure. For each part, the first column gives us the predictive success rate calculated with the sensitivity, percentage of positive sign (net exporter) correctly identified, and the specificity, percentage of negative sign (net importer) correctly identified. We add in the second column a test which compares the predicted results to a random assignment. For the second and third parts, the third column presents the improvement in the goodness of fit (measured by the Fit test) compared to the previous part. For example, for the capital intensive cluster (CAP), accounting for new determinants improves the goodness of fit by 8%, and if we account for difference in ICT and Infrastructure we improve the goodness of fit by 3%.

**Table 4: Quality of prediction for the comparative advantage model**

| | 1: HOV | | 2: HOV + New determinants | | | 3: HOV + New determ. + ICT-Infrastructure | | |
|---|---|---|---|---|---|---|---|---|
| | Fit* | ROC** | Fit* | ROC** | Improv. | Fit* | ROC** | Improv. |
| Agricultural products (AGR) | 70 | 76 | 70 | 76 | 0% | 74 | 78 | 6% |
| Processed Food products (PFO) | 70 | 72 | 70 | 74 | 0% | 72 | 76 | 3% |
| Minerals products (MIN) | 58 | 65 | 63 | 70 | 9% | 64 | 72 | 2% |
| Natural resources intensive (NRK) | 62 | 71 | 64 | 74 | 3% | 65 | 75 | 2% |
| Unskilled Labor intensive (UNL) | 56 | 61 | 76 | 85 | 36% | 78 | 87 | 3% |
| Skilled Labor intensive (SKL) | 72 | 79 | 78 | 88 | 8% | 78 | 89 | 0% |
| Capital intensive (CAP) | 71 | 85 | 77 | 90 | 8% | 79 | 90 | 3% |
| Technological products (TEC)) | 85 | 93 | 86 | 93 | 1% | 89 | 97 | 3% |

* Proportion of correct sign prediction for net exporters and net importers (with the mean of predicted probability as cutoff). ** Receiver Operating Characteristics: Compared to a random prediction (50 means that the model doesn't do any better that random assignment would).

We conclude that adding "new" determinants for trade patterns helps us to improve the prediction to be a net exporter for manufactured products as well as for minerals products. Improvement due to the inclusion of ICT and infrastructure seems to concern all clusters, and especially primary commodity cluster.

As a comparison, in Bowen and al. (1987) the sign test[22] is around 0.6 (it depends on factors). Trefler (1995) with the sign test improves his model from 0.71 (conventional factors) to 0.93 (conventional and "new" determinants). Davis and Weinstein (2001) with the same test improve their model from 0.32 to 0.91. Antweiler and Trefler (2002) obtained a sign test of 0.67 with a strict HOV model and 0.66 with a modification taking into account returns to scale. Here the percentage of signs correctly identified depends on sectors; the"new" determinants do not improve the ROC test for primary and high technology products.

Because of the presence of a number of potentially collinear variables in this first step we implement the variance inflation factor test (VIF). The literature states that in order for an indication of multicolinearity to exist, the value that indicates the highest VIF should be greater than 5. Here we have 4.7 which suggest that multicolinearity is not a serious problem.

### *4.2 Conventional factors versus "new" factors: ANOVA estimates*

As we see in the ANOVA exercises[23] on the predicted probability of being a net exporter of a product (in table 5), the role of conventional factors in accounting for patterns of comparative advantage is still important.

[22] Proportion of observations for which excess in factor endowments and excess in factor content in net export have the same sign.
[23] We report the range of the variance of comparative advantage attributable to traditional factors and to "new" factors.

However concerning some industrial products the new factors could be more important to explain structure of trade. In the conventional factors we add a distinction between capital and land on one hand, and human capital on the other hand, which is sometimes analyzed as a non conventional factor (Lederman and Xu 2001). We perform this test on two periods, 1960-1980 and 1980-2000.

**Table 5: Role of Conventional and New factors in explaining the predicted probability[a]**

| Share of variance explained by: | Period | Land and Capital | Human Capital | New | ICT-Infra | R squared |
|---|---|---|---|---|---|---|
| **Agricultural products** | **1960-2000** | **24%** | **32%** | **4%** | **41%** | **98** |
| **AGR** | 1960-1980 | 15% | 15% | 3% | 67% | |
| | 1980-2000 | 41% | 40% | 13% | 7% | |
| **Processed Food** | **1960-2000** | **48%** | **37%** | **11%** | **4%** | **96** |
| **PFO** | 1960-1980 | 44% | 41% | 10% | 5% | |
| | 1980-2000 | 47% | 41% | 10% | 3% | |
| **Minerals (raw, without oil)** | **1960-2000** | **39%** | **39%** | **8%** | **14%** | **99** |
| **MIN** | 1960-1980 | 25% | 56% | 4% | 16% | |
| | 1980-2000 | 47% | 17% | 7% | 30% | |
| **Natural Resources Intensive** | **1960-2000** | **54%** | **32%** | **6%** | **8%** | **91** |
| **NRK** | 1960-1980 | 27% | 37% | 10% | 25% | |
| | 1980-2000 | 50% | 33% | 4% | 13% | |
| **Unskilled Labor intensive** | **1960-2000** | **5%** | **17%** | **65%** | **13%** | **88** |
| **UNL** | 1960-1980 | 5% | 14% | 70% | 11% | |
| | 1980-2000 | 8% | 45% | 41% | 6% | |
| **Skilled Labor intensive** | **1960-2000** | **26%** | **5%** | **60%** | **9%** | **81** |
| **SKL** | 1960-1980 | 30% | 24% | 43% | 3% | |
| | 1980-2000 | 13% | 5% | 65% | 16% | |
| **Capital intensive** | **1960-2000** | **1%** | **49%** | **42%** | **8%** | **79** |
| **CAP** | 1960-1980 | 2% | 52% | 43% | 3% | |
| | 1980-2000 | 4% | 50% | 41% | 6% | |
| **Technological products** | **1960-2000** | **39%** | **25%** | **26%** | **10%** | **67** |
| **TEC** | 1960-1980 | 21% | 26% | 46% | 8% | |
| | 1980-2000 | 50% | 25% | 15% | 10% | |

[a] The dependent variable in the ANOVA equations is the predicted probability of being a net exporter of the product.

As we could expect, physical capital endowments is not a main determinant to explain the choice of specialization across industrial clusters. Because of its mobility, a country which has more capital could

prefer to transfer it in another country via FDI rather than invest it in a more capital intensive production. In the same way a country relatively less endowed in physical capital could produce more capital intensive goods via FDI from another country. Roughly for primary products the share of traditional factors is greater than the share of new determinants, and inversely for manufactured goods.

The main conclusion about the decomposition in two periods is that effectively conventional factors are not the only determinants of trade patterns but they are as determining as ever during the specialization that took place during the least twenty years. Land abundance is particularly more determining in the last period for primary products, because of the emergence of land abundant developing countries in international trade.

### *4.3 Comparative advantage*

*The role of Conventional factors*

Concerning natural resources, results are encouraging because of the positive and significant sign for the probability of being a net exporter of AGR, PFO and NRK. The results in table 6 imply that a one percent increase in the relative endowment in arable land is associated with an increase in the probability of being a net exporter of PFO of 0.308% (column 2) and of 0.28% for NRK (column 4). Those results confirm earlier estimated found by Leamer (1984), Estervadeordal (1997), Lederman and Xu (2001). The non significance for MIN (column 3) is probably due to the misspecification of endowment in mineral resources (we just measure endowment in arable land). The negative coefficient for land abundance concerning TEC (column 8) conforms to Leamer's view (1999) that countries relatively abundant in land will export land intensive products

and after extracting the capital used in agriculture their capital abundance ratio is less than that of countries not relatively abundant in land[24].

In the case of the capital stock, here again we have good results. The positive sign on MIN and NRK (columns 3 and 4) conforms to the characteristics of those sectors. These results contradict those from Leamer (1984) and Lederman and Xu (2001), but conform to Estervadeordal's results (1997). Concerning manufactured commodities, no study found a significant impact of endowment in capital on labor intensive goods and capital intensive goods[25]. Here by discerning more clusters we find a negative impact on UNL (column 5) and SKL (column 6) and a positive (but weak) impact on CAP (column 7).

Previous studies did not obtain good results on the human capital component. Estervadeordal (1997) found that skilled labor was significantly positive as well as labor intensive goods as capital intensive goods; Lederman and Xu (2001) found that it was significantly negative for all manufactured goods. In discerning three sorts of skills we obtain relatively better results, and the results roughly conform to expectations. An increase in the share of non educated labor or primary educated labor increases the probability of being a net exporter of UNL intensive products. We observe the increase in this probability is greater for a 1% increase in the share of primary educated labor (+0.37%) than for a 1% increase in the share of non educated (+0.18%) meaning that UNL intensive sector needs more primary educated labor than non educated labor.

[24] Leamer explains in this why US in 1947 were a net importer of capital intensive goods from Japan whereas US were more capital intensive than Japan.
[25] In Estervadeordal and Leamer, the impact was positive in the two cases, in Lederman and Xu, the impact was negative on labor intensive goods but non significant on capital intensive goods.

The coefficients appearing in the table are marginal effects calculated for the mean value of the variable. However we assumed a non linear relationship, that is an impact of an increase in capital per labor which differs according to the value of this variable. In the annex we show graphs (Graphs A) for the results of an increase in different factors on the probability of being a net exporter of different groups of products intensive in the factor. We can observe that the impact of increasing the endowment in a factor has no impact until a sufficient level of endowment, hence the impact if stringer until a point where additional endowment do not play anymore on the probability becoming net exporter.

We can conclude by the distinction between the two periods (Table 7 in Annex) that the impact of skill seems more conform to the theory in the second period than in the first one, especially concerning AGR, PFO, MIN and NRK sectors. Concerning these sectors, to be well endowed in unskilled labor is a comparative advantage mainly in the second period. We also observe that the impact of land abundance and capital abundance are more conform to the prediction in the second period. However in the second period, USL sectors seem more sensitive to skilled labor than in the previous period. As expected the endowment in skilled labor is more important in the second period for SKL and TEC sectors.

Regarding capital per labor, its impact is more important and conforms to expectations in the second period for all manufactured products (NRK, UNL, CAP and TEC) as well as for MIN sectors. But it has no more impact on primary sectors (AGR and PFO). Finally results concerning arable land per labor show an increasing and expected impact in the second period for AGR, PFO and NRK sectors. However the results on manufactured products are very mixed and do not really conform to expectations except for the TEC sector.

*The role of "new" determinants*

We saw that "new" determinants are determining, especially concerning manufactured products. Among these factors we assume that because of the presence of "population" which captures scale effects, the log of income per capita captures demand effects. The sign for demand effects should be negative especially for superior goods. Effectively the income per capita rise tends to increase the probability of being a net exporter in inferior goods PFO and UNL (column 2 and 5) and a net importer in superior goods CAP or MIN (column 3 and 7). The scale effects should be positive for products with increasing returns to scale, in industry and especially high technology industry. The results tend to confirm that prediction, since the size of the population is significantly positive for all industrial products (UNL, SKL, CAP and TEC). The measure of factor productivity seems to be more important in the second period (Table 7 in annex), and leads countries to be net exporters of manufactured goods or PFO (column 2). Lederman and Xu (2001) did not account for scale effects and consumers preferences in the comparative advantage equation, so we can not compare our results to their results.

*Infrastructure and ICT*

Roughly, an improvement in those variables leads countries to be net exporters of manufactured products and net importers of primary products. They are not very important in our model so we could assume that they mainly play a role in trade intensity but are not very determining in trade structure. However the distinction in two periods (Table 7 in Annex) shows us that ICT and infrastructure improvements tend to increase the chance for a country to develop a comparative advantage in manufacture industry. An interesting result is that a one percent increase in the infrastructure index increases the probability of being net exporter of

UNL of 0.32 as important as a one percent increase in primary educated labor.

**Table 6: Determinants of Comparative Advantage: Heckman selection equation: Probit on the probability of being a net exporter of each commodity cluster on 1960-2000**.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Probability of being a net exporter | **Agr. AGR** | **Pr. Food PFO** | **Minerals MIN** | **Nat. Res. NRK** | **Uns. Lab. UNL** | **Sk. Lab. SKL** | **Capital CAP** | **Technol. TEC** |
| Capital | -0.145** | -0.207*** | 0.367*** | 0.299*** | -0.343*** | -0.101** | 0.003* | 0.000001 |
| | (2.10) | (3.05) | (4.58) | (4.09) | (4.89) | (2.07) | (1.85) | (0.90) |
| Land | 0.157*** | 0.308*** | -0.048* | 0.280*** | 0.068** | -0.052*** | 0.001 | -0.000001*** |
| | (4.74) | (7.57) | (1.68) | (7.39) | (2.46) | (3.71) | (1.59) | (3.88) |
| Unskilled | -0.054 | 0.107*** | 0.086** | 0.164*** | 0.180*** | -0.004 | -0.002** | -0.000000 |
| | (1.47) | (2.76) | (2.32) | (4.26) | (4.10) | (0.28) | (2.51) | (1.03) |
| Primary | -0.116** | 0.158** | -0.170*** | 0.222*** | 0.371*** | 0.111*** | 0.005*** | 0.000001* |
| | (2.01) | (2.37) | (2.90) | (3.47) | (5.36) | (3.78) | (2.97) | (1.91) |
| High-Secondary | -0.035 | -0.015 | 0.247*** | 0.262*** | 0.080 | 0.090*** | 0.001 | 0.000001 |
| | (0.58) | (0.25) | (4.18) | (4.40) | (1.18) | (2.84) | (0.56) | (0.73) |
| Income p.c. | 0.058 | 0.281*** | -0.222* | -0.143 | 0.310*** | 0.061 | -0.004* | -0.000002 |
| | (0.50) | (2.59) | (1.80) | (1.26) | (2.77) | (0.82) | (1.66) | (1.43) |
| Population | -0.045** | -0.022 | 0.037* | -0.016 | 0.172*** | 0.061*** | 0.003*** | 0.000001*** |
| | (2.15) | (0.97) | (1.73) | (0.72) | (7.65) | (5.86) | (5.74) | (5.54) |
| TFP | 0.031 | 0.357*** | -0.223* | 0.045 | 0.466*** | 0.140** | 0.009*** | -0.000000 |
| | (0.22) | (2.65) | (1.71) | (0.35) | (3.75) | (2.03) | (3.10) | (0.38) |
| ICT | 0.006 | -0.047** | -0.007 | 0.028 | -0.075*** | -0.002 | -0.000 | 0.000000* |
| | (0.27) | (2.09) | (0.33) | (1.38) | (3.68) | (0.22) | (0.40) | (1.84) |
| Infrastructure | -0.002 | 0.132* | -0.206*** | -0.120* | 0.322*** | 0.051 | 0.004** | 0.000002** |
| | (0.02) | (1.81) | (2.77) | (1.71) | (4.41) | (1.32) | (2.10) | (2.31) |
| Regional Dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 461 | 461 | 443 | 465 | 461 | 462 | 456 | 454 |

The coefficients are the marginal coefficients.

### *4.4 Intensity of Trade*

Among the structural variables, the size of the country, measured by population, presents robust results in reducing net exports for net exporters (table 8) and reducing the net imports for importer (table 9) in most goods. Here population does not capture scale effects but only the country's size. We disagree with Lederman and Xu (2001) who find the same results as ours but interpret this variable as a scale effect. In fact, having a large domestic market size reduces trade flows. The result concerning income per capita does not show clear results on the impact of consumer's preferences, whereby they would prefer to consume superior goods when their income increases. It seems that income per capita, as population, captures a market size effect which decreases the net exports for net exporters and decreases net imports for net importers. We showed that difference in technology could explain trade specialization we see here that differences in productivity might affect trade patterns in affecting trade intensity, since an improvement in the productivity lead countries, net exporters as net importers, to increase its nets exports in manufactured products. The trade flows are significantly determined by transport costs (infrastructure) and seem less sensitive to transaction cost (ICT).

Concerning the policy trade measure we obtain an interesting and robust result. The policy trade variable has increased net exports for net exporters and net imports for net importers. The results are quite different among clusters. It seems that for net importers (Table 9) protection tends to favor capital intensive and technological intensive products. This means that this measure of trade policy is robust and captures a sort of specialization. It is a test of validity for this sort of measure (e.g. adjusted trade ratio by residuals), sometimes criticized. Graphs in annex (Graphs B), show this non linearity concerning the impact of openness on net exports

between next exporter and net importer. Our cluster classification allows us to obtain better results on the policy openness impact than Lederman and Xu (2001) who used Leamer's classification. We observe also in the coefficients in table 8 and 9 that if trade liberalization stimulated export growth it raised import growth by more as in Santos Paulino and Thirwall (2004).

**Table 8: Trade intensity: Heckman's second equation: OLS on net exports for net exporters**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| $Ln\left(c+\frac{X-M}{PIB}\right)$ | **Agr. AGR** | **Pr. Food PFO** | **Minerals MIN** | **Nat. Res. NRK** | **Uns. Lab. UNL** | **Sk. Labor SKL** | **Capital CAP** | **Technol. TEC** |
| Income p.c. | -0.031 | -0.048* | 0.053** | -0.161** | -0.126*** | 0.004 | -0.143*** | -0.154 |
| | (0.82) | (1.66) | (2.17) | (2.02) | (3.72) | (0.31) | (3.58) | (1.46) |
| Population | -0.055*** | -0.041*** | -0.013*** | -0.051*** | -0.018** | 0.002 | -0.048*** | -0.007 |
| | (7.18) | (5.05) | (2.99) | (3.69) | (2.04) | (0.37) | (5.39) | (0.21) |
| TFP | -0.029 | 0.025 | -0.001 | -0.099 | 0.137*** | 0.048** | 0.119* | 0.183* |
| | (0.63) | (0.62) | (0.03) | (1.48) | (3.10) | (2.09) | (1.70) | (1.91) |
| Partner Growth | -0.034 | 0.205** | -0.271** | 0.268 | 0.005 | 0.062* | -0.145 | 0.383 |
| | (0.29) | (2.35) | (2.59) | (1.32) | (0.06) | (1.70) | (1.39) | (1.37) |
| Landlockness | -0.169*** | 0.036 | 0.167** | 0.177** | -0.148*** | 0.012 | -0.226*** | 0.255*** |
| | (3.94) | (0.80) | (2.49) | (2.51) | (5.31) | (0.92) | (7.87) | (3.03) |
| Infrastructure | -0.082*** | 0.042** | -0.053*** | 0.067 | 0.066** | -0.008 | 0.122*** | 0.185* |
| | (2.75) | (2.17) | (3.69) | (1.33) | (2.59) | (0.45) | (3.60) | (1.74) |
| ICT | -0.011 | -0.014** | -0.001 | -0.002 | 0.016* | 0.005 | 0.004 | 0.015 |
| | (1.61) | (2.46) | (0.23) | (0.29) | (1.70) | (0.88) | (0.65) | (1.29) |
| Pol. Open | 0.093*** | 0.055*** | 0.033*** | 0.028 | 0.067*** | 0.041*** | -0.039 | 0.067 |
| | (3.61) | (3.85) | (3.09) | (1.04) | (3.92) | (3.91) | (1.19) | (0.63) |
| Mills Ratio | -0.044 | -0.020 | -0.044* | -0.211** | -0.021 | 0.013 | 0.075*** | 0.149** |
| | (1.62) | (0.90) | (1.86) | (2.45) | (1.22) | (0.58) | (2.92) | (2.08) |
| Constant | 8.687*** | 7.684*** | 7.555*** | 8.742*** | 8.338*** | 6.743*** | 9.373*** | 7.249*** |
| | (21.03) | (23.59) | (21.91) | (11.69) | (20.24) | (27.88) | (17.05) | (5.51) |
| Observations | 264 | 240 | 199 | 180 | 157 | 89 | 78 | 62 |
| R-squared | 0.42 | 0.27 | 0.31 | 0.35 | 0.33 | 0.32 | 0.52 | 0.43 |

The Mills' inverse ratio, which estimates the correlation between the error from comparative advantage equation and the error from trade

intensity equations, is sometimes significant. This suggests that part of trade intensity not explained by the explanatory variables are significantly correlated with unexplained comparative advantage, and that explanatory variables in the second step (trade intensity) are correlated with unobserved variables in the first step (comparative advantage). So, in correcting for that correlation, we have avoided a bias in the estimation of parameters in the second step.

**Table 9: Trade intensity: Heckman's second equation: OLS on net exports for net importers**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| $Ln\left(c+\frac{X-M}{PIB}\right)$ | **Agr. AGR** | **Pr. Food PFO** | **Minerals MIN** | **Nat. Res. NRK** | **Uns. Lab. UNL** | **Sk. Lab. SKL** | **Capital CAP** | **Technol. TEC** |
| Income p.c. | 0.039** | -0.008 | -0.000 | -0.005 | 0.010 | 0.017*** | 0.019 | 0.043** |
| | (2.39) | (0.62) | (0.03) | (1.36) | (1.07) | (4.17) | (1.34) | (2.52) |
| Population | 0.011*** | 0.008*** | -0.002** | 0.004*** | 0.017*** | 0.014*** | 0.044*** | 0.038*** |
| | (3.68) | (2.71) | (2.21) | (4.38) | (6.15) | (10.38) | (13.67) | (10.30) |
| TFP | 0.014 | 0.046** | -0.017*** | -0.002 | 0.029** | 0.026*** | 0.058** | 0.072* |
| | (0.67) | (2.45) | (2.98) | (0.43) | (2.32) | (2.94) | (1.98) | (1.92) |
| Partner Growth | 0.008 | 0.026 | -0.004 | 0.003 | -0.144*** | 0.007 | -0.030 | 0.073 |
| | (0.12) | (0.67) | (0.31) | (0.20) | (3.98) | (0.52) | (0.56) | (1.40) |
| Landlockness | 0.034** | 0.007 | -0.006* | -0.005 | 0.023*** | 0.009 | 0.018 | 0.031 |
| | (2.31) | (0.73) | (1.91) | (1.26) | (3.37) | (1.42) | (1.25) | (1.57) |
| Infrastructure | -0.018 | 0.009 | -0.010*** | 0.002 | -0.016* | -0.008** | -0.011 | -0.026** |
| | (1.45) | (1.03) | (2.95) | (0.80) | (1.80) | (2.48) | (1.11) | (2.01) |
| ICT | 0.008** | 0.005** | 0.003*** | 0.001 | 0.002 | -0.006*** | -0.000 | -0.005 |
| | (2.53) | (2.00) | (2.85) | (0.87) | (1.02) | (4.45) | (0.12) | (0.76) |
| Pol. Open | -0.023 | -0.052*** | -0.013*** | -0.018*** | -0.035*** | -0.031*** | -0.136*** | -0.151*** |
| | (1.65) | (3.81) | (3.29) | (5.85) | (4.17) | (8.95) | (10.97) | (8.77) |
| Mills Ratio | 0.028** | 0.056*** | -0.005 | 0.009*** | 0.039*** | 0.013 | 0.039* | 0.130*** |
| | (2.38) | (5.06) | (0.99) | (3.74) | (4.02) | (1.33) | (1.77) | (6.08) |
| Constant | 6.307*** | 6.688*** | 6.978*** | 6.881*** | 6.893*** | 6.497*** | 5.974*** | 5.558*** |
| | (27.86) | (47.75) | (146.26) | (159.54) | (73.25) | (142.80) | (38.39) | (27.36) |
| Observations | 197 | 221 | 244 | 285 | 304 | 373 | 378 | 392 |
| R-squared | 0.27 | 0.42 | 0.24 | 0.30 | 0.44 | 0.57 | 0.59 | 0.52 |

## 5 Conclusions

We have tried to improve the commodity version of the HO model by adding the "new" determinants (trade impediments, differences in technology, in consumers' preferences and in returns to scale) developed in the factor content literature as well as determinants in trade structure and in trade intensity, in using a non linear estimation. This lead us to implement a Heckman procedure where in the first step we estimate the probability of being a net exporter for each eight cluster of products (what we call the comparative advantage equation). We include in this step as explanatory variables factor endowments and the new determinants which may affect specialization. In the second step, we estimate the trade intensity of net exports for each cluster depending on new determinants as well as on trade policy. This procedure helps us to control for the correlation between the unobserved variables which explain trade specialization and the explanatory variables of trade intensity. We also used a more detailed cluster classification allowing leading to more clusters for manufactured products. The eight clusters are: agriculture, processed food, minerals, natural resources based- manufactures (NRB), unskilled labor intensive (USK), skilled labor intensive (SK), capital intensive (K) and technology intensive (T). And we distinguish three sorts of skills to better assess the specialization according to human capital. All our factor endowments measures are weighted relative to world factor endowments.

Our principal results are as follows. First we find that conventional factors are still important in determining trade structure, arguably because we have a better measure of factor endowment (e.g the endowment of a country is weighted by the mean endowment in the world) and a better cluster classification. Second we find that new determinants (e.g. difference in productivity, consumers' preferences and scale returns) need to be

included to determine comparative advantage, especially for the manufactured products. Controlling for factor endowments, a better technology or scale economies enhance comparative advantage for manufactured products. Moreover, an increase in mean income leads consumers to prefer superior goods (capital intensive products or minerals intensives products) relative to inferior goods (low skilled labor intensive products and processed food) which change net exports structure. An improvement in information and communication technology or infrastructure also helps a country to reduce dependence on primary products.

Next, turn to change across periods. The results indicate that differences in factor endowments have not diminished through time: we observe an increase in the specialization according to skill endowment. So difference in productivity, in returns to scale or in consumers preferences are not new forces that drive trade flows, they were also important before 1980. It is an important conclusion since no study has been investigating this aspect before.

Estimation of trade intensity also yields plausible results. First country size matters as expected, as trade intensity decreases with population. Second a reduction in our proxy for trade barriers, increases trade intensity for both net exporter and for net importers clusters. However its effects are not uniform among sectors. Third a reduction in barriers to trade increase trade intensity, with a stronger effect for infrastructure-related costs than for transaction-related costs. Finally for manufactured clusters, increases in TFP raises net exports and reduces net imports for manufactured products. As to the overall two-step procedure, the statistical test (Mills ratio) accepts the two-step procedure.

In sum, the specialization according to factor endowments is always relevant, although "new" determinants of trade patterns are necessary to explain specialization and trade intensity.

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# APPENDICES

***A.1:*** *List of countries included in the sample 1970-2000*

| | Countries | observations |
|---|---|---|
| Latin America | Argentina | 8 |
| | Bolivia | 8 |
| | Brazil | 8 |
| | Chile | 8 |
| | Colombia | 8 |
| | Costa Rica | 7 |
| | Dominican Republic | 5 |
| | Ecuador | 8 |
| | El Salvador | 8 |
| | Guatemala | 7 |
| | Honduras | 8 |
| | Jamaica | 7 |
| | Mexico | 8 |
| | Nicaragua | 7 |
| | Panama | 8 |
| | Paraguay | 8 |
| | Peru | 8 |
| | Trinidad and Tobago | 6 |
| | Uruguay | 6 |
| | Venezuela, RB | 8 |
| **Total** | **20** | **149** |
| Developed Countries | Australia | 7 |
| | Austria | 7 |
| | Belgium | 1 |
| | Canada | 7 |
| | Cyprus | 5 |
| | Denmark | 6 |
| | Finland | 7 |
| | France | 8 |
| | Greece | 8 |
| | Ireland | 8 |
| | Italy | 8 |
| | Japan | 8 |
| | Netherlands | 7 |
| | New Zealand | 5 |
| | Norway | 7 |
| | Portugal | 8 |
| | Spain | 8 |
| | Sweden | 8 |
| | Switzerland | 8 |
| | United Kingdom | 8 |
| | United States | 8 |
| **Total** | **21** | **147** |

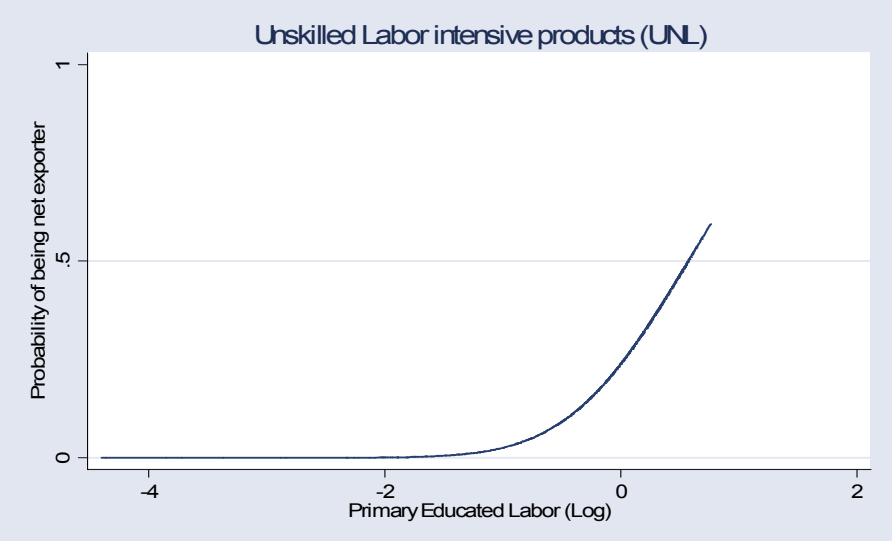
| | Countries | observations |
|---|---|---|
| Africa and Middle East | Algeria | 6 |
| | Egypt, Arab Rep. | 5 |
| | Ghana | 7 |
| | Iran, Islamic Rep. | 3 |
| | Israel | 8 |
| | Jordan | 7 |
| | Kenya | 5 |
| | Mali | 7 |
| | Mauritius | 6 |
| | Rwanda | 1 |
| | Senegal | 8 |
| | Sierra Leone | 4 |
| | South Africa | 4 |
| | Tanzania | 2 |
| | Tunisia | 8 |
| | Turkey | 7 |
| | Uganda | 2 |
| | Zambia | 4 |
| | Zimbabwe | 4 |
| **Total** | **19** | **98** |
| Asia | Bangladesh | 5 |
| | China | 4 |
| | India | 8 |
| | Indonesia | 7 |
| | Korea, Rep. | 8 |
| | Malaysia | 7 |
| | Pakistan | 6 |
| | Philippines | 8 |
| | Singapore | 8 |
| | Sri Lanka | 8 |
| | Thailand | 8 |
| **Total** | **11** | **77** |

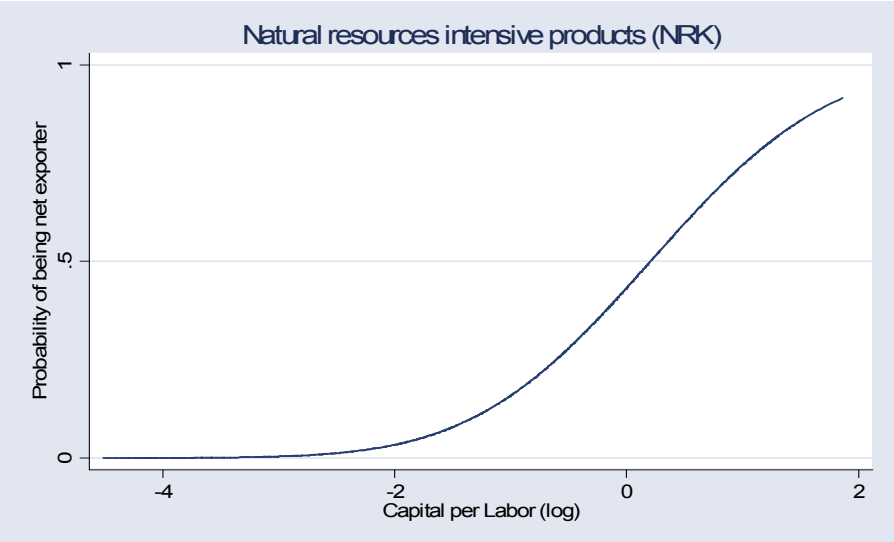
| | | |
|---|---|---|

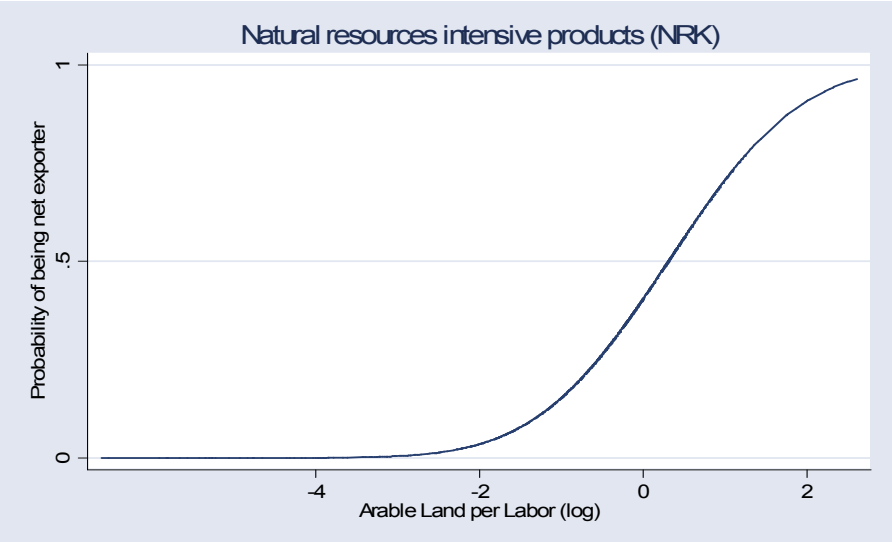
*A.2: Variance of variables*

| | | Between | Within | Between/Within |
|---|---|---|---|---|
| **Net Exports** | | | | |
| | Agriculture (AGR) | 0,21 | 0,06 | 3,48 |
| | Pr. Food (PFO) | 0,15 | 0,04 | 3,43 |
| | Minerals (MIN) | 0,10 | 0,03 | 3,91 |
| | Nat. Resources (NRK) | 0,14 | 0,02 | 5,53 |
| | Unskilled Labor (UNL) | 0,11 | 0,04 | 2,64 |
| | Skilled Labor (SKL) | 0,05 | 0,02 | 2,41 |
| | Capital (CAP) | 0,17 | 0,05 | 3,38 |
| | Technology (TEC) | 0,21 | 0,08 | 2,55 |
| **Predicted Probability** | | | | |
| | Agriculture (AGR) | 0,27 | 0,04 | 6,81 |
| | Pr. Food (PFO) | 0,27 | 0,06 | 4,23 |
| | Minerals (MIN) | 0,25 | 0,09 | 2,82 |
| | Nat. Resources (NRK) | 0,31 | 0,07 | 4,46 |
| | Unskilled Labor (UNL) | 0,31 | 0,10 | 3,13 |
| | Skilled Labor (SKL) | 0,26 | 0,05 | 5,18 |
| | Capital (CAP) | 0,26 | 0,05 | 4,98 |
| | Technology (TEC) | 0,29 | 0,04 | 7,39 |
| **Explanatory variables** | | | | |
| | Income p.c. | 0,94 | 0,18 | 5,08 |
| New determinants | Population | 1,47 | 0,15 | 10,06 |
| | TFP | 0,26 | 0,15 | 1,72 |
| | Growth Partners | 0,05 | 0,08 | 0,56 |
| | Infrastructure | 1,31 | 0,22 | 5,89 |
| | ICT | 0,88 | 0,72 | 1,23 |
| | Openness | 0,33 | 0,16 | 2,05 |
| | **Land** | **1,14** | **0,11** | **10,67** |
| | **Capital** | **1,32** | **0,21** | **6,37** |
| Factor's endowments | **Unskilled** | **1,38** | **0,24** | **5,76** |
| | **Primary** | **0,52** | **0,18** | **2,88** |
| | **Highly & Secondary** | **0,78** | **0,23** | **3,34** |

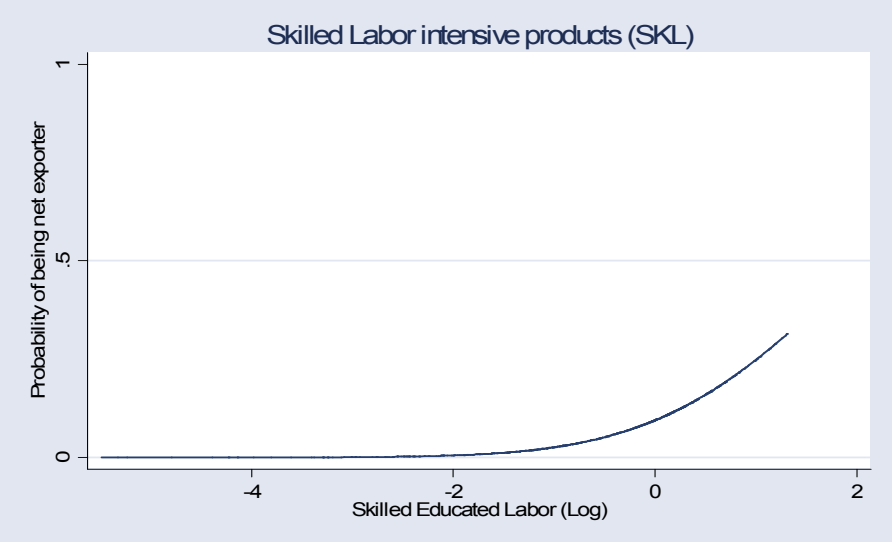
***A.3:*** *Graphs Non linearity between factor endowments and probability of being net exporter*

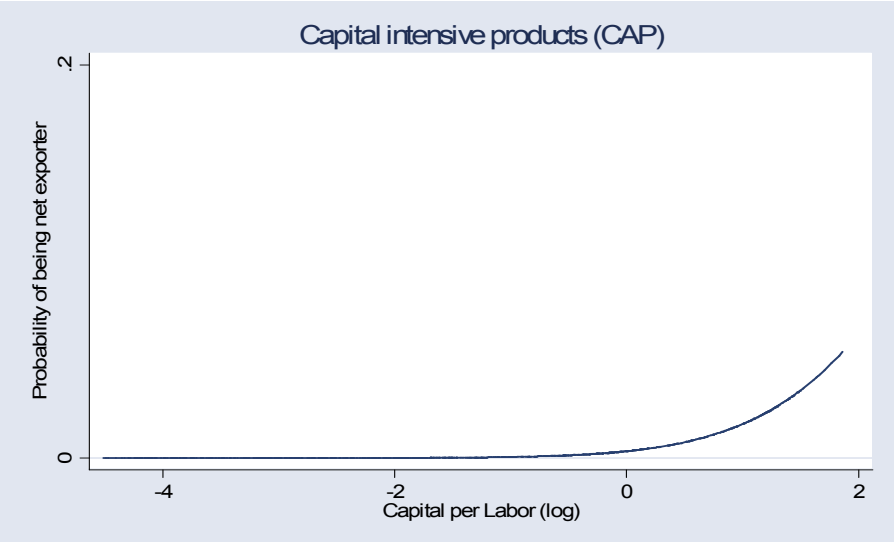



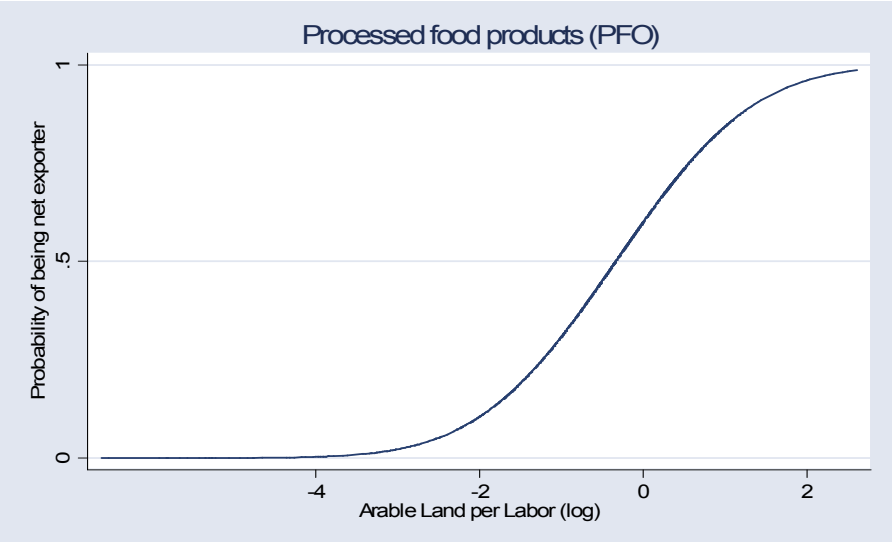




Skilled Labor intensive products (SKL)
Probability of being net exporter
0
.5
1
-4
-2
0
2
Capital per Labor (log)


Skilled Labor intensive products (SKL)
Probability of being net exporter
0
.5
1
-4
-2
0
2
Skilled Educated Labor (Log)


Capital intensive products (CAP)
Probability of being net exporter
0
.2
-4
-2
0
2
Capital per Labor (log)

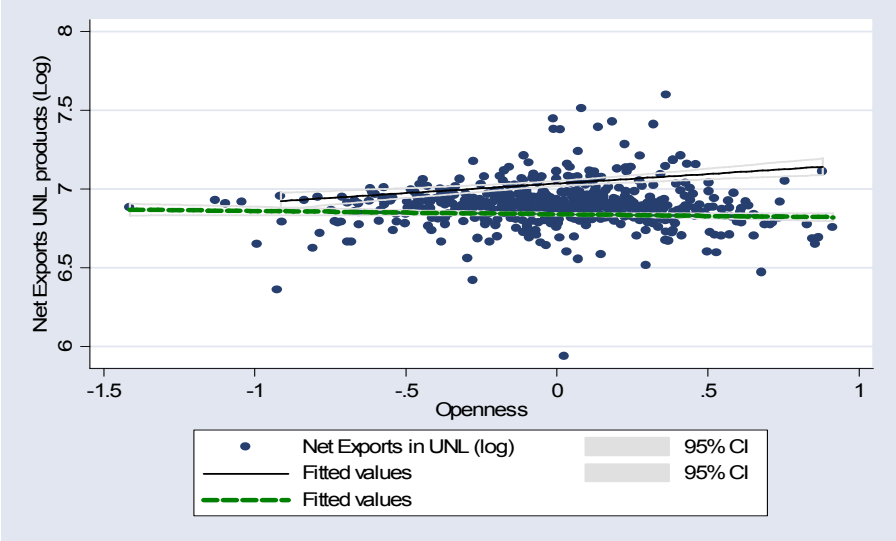

Processed food products (PFO)
Probability of being net exporter
0
.5
1
-4
-2
0
2
Arable Land per Labor (log)

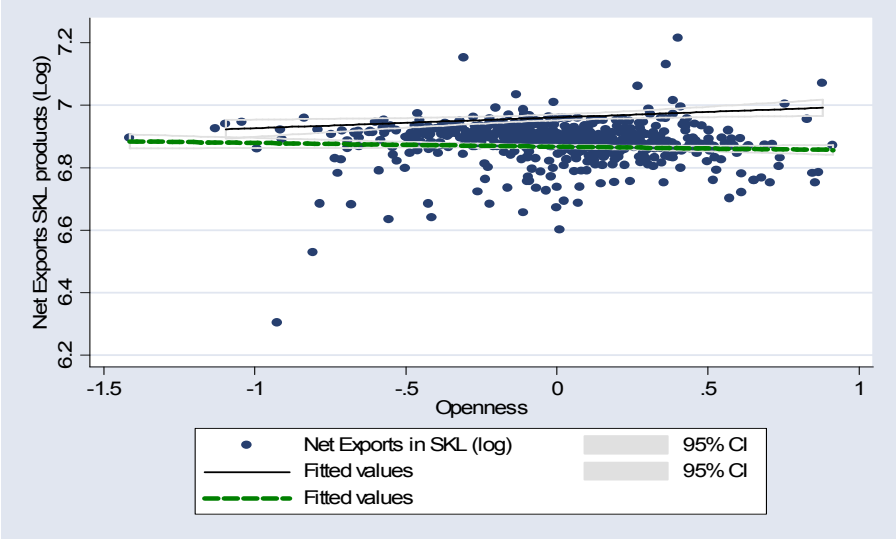
***A.4:*** *Determinants of Comparative Advantage: Probit on the probability of being a net exporter of each commodity cluster for 1960-1980 and 1980-2000.*

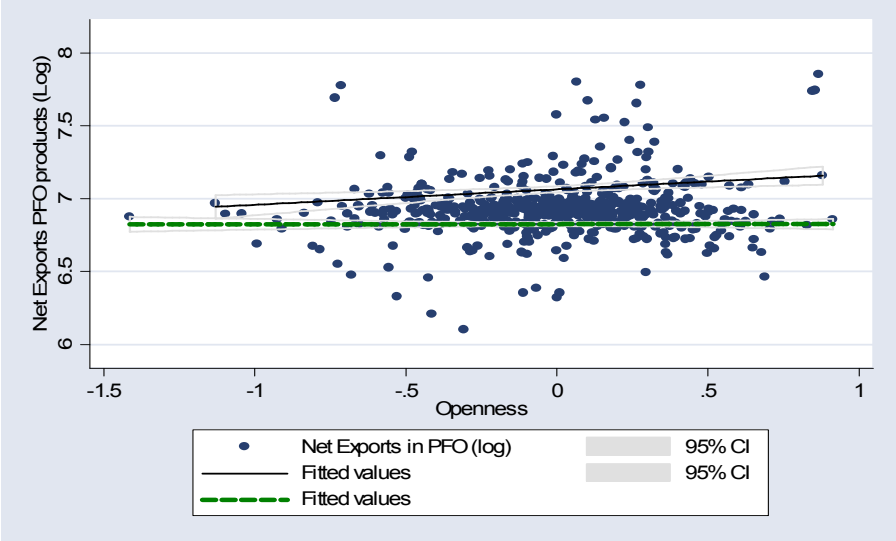
| Probability of being a net exporter | **Agr. AGR** | **Agr. AGR** | **Pr. Food PFO** | **Pr. Food PFO** | **Minerals MIN** | **Minerals MIN** | **Nat. Res. NRK** | **Nat. Res. NRK** |
|---|---|---|---|---|---|---|---|---|
| **Period** | **1960-1980** | **1980-2000** | **1960-1980** | **1980-2000** | **1960-1980** | **1980-2000** | **1960-1980** | **1980-2000** |
| Capital | -0.275*** | 0.074 | -0.436*** | -0.042 | 0.326*** | 0.766*** | 0.186** | 0.697*** |
| | (2.93) | (0.80) | (4.11) | (0.36) | (2.98) | (5.27) | (2.12) | (4.93) |
| Land | 0.078 | 0.222*** | 0.429*** | 0.354*** | 0.037 | -0.127*** | 0.211*** | 0.446*** |
| | (1.60) | (3.76) | (5.35) | (5.87) | (0.79) | (3.29) | (4.52) | (6.62) |
| Unskilled | -0.190*** | -0.078 | 0.147 | 0.112* | -0.038 | 0.165** | 0.207** | 0.237*** |
| | (3.30) | (1.50) | (1.50) | (1.85) | (0.51) | (2.13) | (2.20) | (3.59) |
| Primary | -0.065 | -0.152 | 0.538*** | 0.186 | -0.266* | -0.095 | 0.056 | 0.236* |
| | (0.71) | (1.57) | (3.24) | (1.55) | (1.74) | (0.63) | (0.32) | (1.78) |
| High-Secondary | -0.098 | -0.240** | 0.295* | 0.168 | 0.488*** | 0.191 | 0.303** | 0.186 |
| | (1.11) | (2.32) | (1.81) | (1.57) | (3.77) | (1.33) | (2.33) | (1.38) |
| Income p.c. | 0.054 | -0.193 | 0.385** | 0.076 | -0.144 | -0.518** | 0.003 | -0.278 |
| | (0.33) | (1.19) | (2.30) | (0.41) | (0.88) | (2.56) | (0.02) | (1.38) |
| Population | -0.007 | -0.032 | 0.012 | -0.059* | -0.010 | 0.065** | 0.014 | 0.001 |
| | (0.21) | (1.06) | (0.32) | (1.79) | (0.30) | (2.17) | (0.44) | (0.04) |
| TFP | -0.240 | -0.037 | -0.147 | 0.521*** | -0.390 | -0.268* | 0.150 | 0.056 |
| | (0.74) | (0.25) | (0.47) | (3.11) | (1.27) | (1.70) | (0.50) | (0.32) |
| ICT | 1.127** | -0.011 | -1.289** | -0.038 | -2.172*** | 0.001 | -0.145 | 0.012 |
| | (2.32) | (0.40) | (2.34) | (1.24) | (3.88) | (0.04) | (0.32) | (0.42) |
| Infrastructure | -0.187 | 0.150 | 0.490*** | 0.165 | 0.226* | -0.353*** | -0.122 | -0.318*** |
| | (1.49) | (1.28) | (3.61) | (1.49) | (1.84) | (2.85) | (1.02) | (2.89) |
| Regional Dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 213 | 248 | 212 | 249 | 202 | 241 | 214 | 251 |

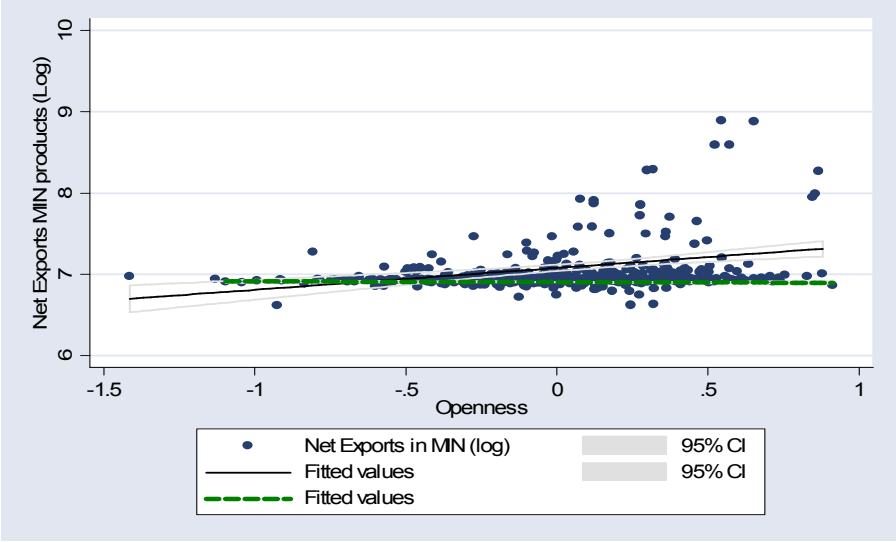
| Probability of being a net exporter | **Uns. Lab. UNL** | **Uns. Lab. UNL** | **Sk. Lab. SKL** | **Sk. Lab. SKL** | **Capital CAP** | **Capital CAP** | **Technol. TEC** | **Technol. TEC** |
|---|---|---|---|---|---|---|---|---|
| **Period** | **1960-1980** | **1980-2000** | **1960-1980** | **1980-2000** | **1960-1980** | **1980-2000** | **1960-1980** | **1980-2000** |
| Capital | -0.240*** | -0.797*** | -0.109*** | -0.006 | -0.000** | 0.084*** | 0.000000 | 0.000077 |
| | (4.51) | (4.86) | (3.62) | (0.16) | (2.48) | (2.74) | (0.22) | (0.76) |
| Land | -0.048* | 0.126*** | -0.044*** | -0.005 | 0.000** | 0.017* | -0.000000** | -0.000059** |
| | (1.85) | (2.82) | (4.01) | (0.51) | (2.11) | (1.69) | (2.04) | (2.10) |
| Unskilled | -0.015 | 0.440*** | -0.022** | -0.034** | -0.000*** | -0.023** | -0.000000 | 0.000001 |
| | (0.59) | (4.49) | (2.25) | (2.43) | (2.75) | (2.28) | (1.39) | (0.03) |
| Primary | 0.134** | 0.648*** | 0.106*** | 0.019 | 0.000** | 0.017 | 0.000000 | 0.000056 |
| | (2.52) | (5.32) | (3.24) | (0.76) | (2.04) | (0.61) | (0.89) | (0.94) |
| High-Secondary | -0.182*** | 0.910*** | 0.049** | 0.106** | 0.000** | -0.055* | 0.000000 | 0.000213** |
| | (3.60) | (4.50) | (2.10) | (2.38) | (2.50) | (1.81) | (0.62) | (2.14) |
| Income p.c. | 0.072 | 0.723*** | 0.015 | -0.067 | -0.000 | -0.034 | -0.000000* | -0.000221 |
| | (0.84) | (3.59) | (0.41) | (1.24) | (1.10) | (0.83) | (1.88) | (1.49) |
| Population | 0.141*** | 0.186*** | 0.044*** | 0.039*** | 0.000*** | 0.031*** | 0.000000*** | 0.000046*** |
| | (6.80) | (4.34) | (5.64) | (5.70) | (3.62) | (4.54) | (5.31) | (2.93) |
| TFP | 0.263* | 0.667*** | -0.035 | 0.122** | 0.000*** | 0.100*** | 0.000000 | -0.000039 |
| | (1.68) | (3.82) | (0.64) | (2.37) | (3.40) | (2.69) | (0.89) | (0.47) |
| ICT | 1.458*** | -0.103*** | 0.147 | -0.002 | 0.000*** | -0.002 | 0.000000 | 0.000020* |
| | (5.42) | (3.23) | (1.35) | (0.39) | (2.88) | (0.26) | (1.45) | (1.95) |
| Infrastructure | -0.025 | 0.229 | 0.026 | 0.084*** | -0.000** | 0.036 | 0.000000*** | 0.000143* |
| | (0.35) | (1.54) | (0.87) | (2.93) | (2.38) | (1.17) | (4.07) | (1.65) |
| Regional Dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 213 | 248 | 213 | 249 | 214 | 242 | 213 | 241 |

***A.5:*** *Graphs Non linearity between Openness and Net Exports for status S=1 and S=0*




Net Exports PFO products (Log)
6
6.5
7
7.5
8
-1.5
-1
-.5
0
.5
1
Openness
Net Exports in PFO (log)
Fitted values
Fitted values
95% CI
95% CI


Net Exports MIN products (Log)
6
7
8
9
10
-1.5
-1
-.5
0
.5
1
Openness
Net Exports in MIN (log)
Fitted values
Fitted values
95% CI
95% CI

# CHAPTER 2: OPPENESS AND INEQUALITY IN DEVELOPING COUNTRIES: A NEW LOOK AT THE EVIDENCE


***Abstract***

Integration to world markets is expected to help developing countries to access prosperity. At the same time, increasing opportunities to trade are likely to affect income distribution and whether or not increasing openness to trade is accompanied by a reduction or an increase inequality is highly controversial. This paper brings new evidence on this issue in using a data set covering a large sample of developing countries and a model with improved controls for omitted variables and a new index of trade openness. Trade liberalization increases inequality in countries that relatively well-endowed in capital. Our model assumes that it might be fruitful to breakdown unskilled labor into non-educated and primary-educated as suggested by Wood (1994). The results show that trade liberalization increases inequality in highly educated abundant countries whereas it decreases inequality in primary educated abundant countries. However it increases inequality in non educated abundant countries, suggesting that this part of population does not benefit from trade openness since it is not included in export oriented sectors.



JEL classification: F11, F16, D3

Keywords: International Trade, Income Distribution, Poverty

## 1 Introduction

Integration to world markets is expected to help developing countries to access prosperity. At the same time, increasing opportunities to trade are likely to affect income distribution and whether or not increasing openness to trade is accompanied by a reduction or an increase inequality is highly controversial. Indeed, in a recent review of the literature, Anderson (2005) concludes that the evidence is very mixed "Recent years have witnessed many empirical studies on the effects of openness on inequality in developing countries. On the one hand, several detailed time-series studies of individual middle income developing countries have shown that increased openness has raised the relative demand for skilled labor. On the other hand, cross-country econometric evidence suggests that increased openness has had little impact on overall inequality in developing countries. This is a puzzle, because we would expect a rise in the relative demand for skilled labor to increase overall inequality, all else being equal."

Two mains approaches have been used extensively study the relationship between trade and inequality. One relies on wage difference in manufacturing industry and consists in time series studies by country. While these studies have the advantage to be adessed to the underlying factor proposition of the Hecksher Ohlin Samuelson (HOS) model used in the debate, they do not take into account the effects of commodity price changes on purchasing power and are confined to a sector which often represents a small sector of the economy in low income countries. Moreover, these studies usually account only for two factors, skilled and unskilled labor, without including the well being in the global economy and concern only middle income developing countries.

The second approach, which we adopt here, uses a measure of inequality on global income, the Gini coefficient, and consists in panel studies. While this approach, in considering global income, includes more than two factors production, and extends the traditional HOS model, it seems to us more appropriate to analyze inequality in developing countries since it includes all the population. Moreover it allows including low income countries.

Under this approach the investigation aims to determine if trade openness effectively decreases inequality in developing countries relative to developed countries. However, developing countries no longer form a homogenous group of countries merely better endowed in unskilled labor. Hence recent studies test the impact of trade according to relative endowment in unskilled labor, skilled labor, physical capital and land. They are more in line with international trade theories.

In this study we extend previous analyses that have relied only on two sorts of labor factor (skilled and unskilled) since we distinguish between two sorts of unskilled labor, non educated and primary educated, arguing that the impact of trade openness according to human capital is a non linear relationship. Indeed, with three types of labor (no education, basic and highly skilled), Wood (1994) argues that openness in poor countries might increase inequalities by helping those with basic education and leaving even further behind those with no education. Only when the poor become reasonably skilled, can the low deciles share begin to benefit from increased labor demand. Milanovic's (2002) analysis is similar; studying the impact of trade openness on deciles, according to the mean income of countries, he finds that for low income countries it is the rich who benefit from openness, as mean income level rises, (for countries like Colombia, Chile) the relative income of poor and middle class increase compared to the rich during the trade liberalization. Trade openness does not benefit the

poorest deciles in poor countries (who have no education) but to the poorest deciles in middle income countries (who have basic education). More recently Bensidoun et al. (2005) find that international trade raises income inequalities for countries with a no educated share greater than 30%.

Several other factors may contribute to the difference between the usual findings and ours.

(i) Differences in the sample of countries: several studies restrict attention to considerably smaller and possibly a non representative sample of countries compared to the 75 which appear in our database and provide 360 observations on five years average periods. It seems more representative since it includes more observations concerning developing countries than developed countries.

(ii) Differences in the measure of trade openness: in order to cover a large period (for which tariffs are not available), several studies focus on the output ratio for which a large part is only linked to structural factors in the country and does not indicate the change in prices. Others use the Sachs-Warner index which has been criticized for proxying the overall policy environment rather than openness. Since we are interested in the outwardness of countries in terms of both imports and exports (and their ability to access to developed country markets) we avoid also the tariffs measure which captures only the protection from imports and which does not cover a large period. We use a new measure of adjusted trade openness based on a gravity model as Hiscox and Kastner (2002).

(iii) Differences in econometric specification and technique: we correct for heteroskedasticity and we include country fixed effects in our estimation to control for countries heterogeneity, contrary to most previous studies which used OLS estimator. Trying to explain cross-country differences in levels of inequality is not easy, since a number of factors cannot be properly

taken into account. As a consequence, econometric estimates are likely to be flawed with omitted variable bias. In addition, the interesting issue from a policy perspective is not whether countries with different degrees of openness exhibit different levels of inequality, but rather whether an increase in a country's trade openness is associated with an increase or a decrease in inequality. Even from a theoretical perspective, the predictions of the HOS framework do not refer to cross-country comparison of levels of inequality, but rather to their changes as countries open up to trade.

To anticipate our results, we find that trade openness raises income inequalities both for non educated abundant countries and for highly educated abundant countries. Inversely trade liberalization decreases inequality for countries well endowed in primary educated labor. These results confirm Wood (1994) framework. The policy implication of these results is to know how trade can lead to decreasing income inequalities in developing countries: implement basic education in order that all workers benefit from trade openness. Workers in developing countries need to acquire a reasonable level of skill to benefit from trade liberalization. Our results suggest that countries with at least 20% of primary educated labor will have decreasing inequalities during their liberalization, whereas countries with at least 20% of no educated labor will have increasing inequalities. In addition, once we control for country specificity we find also that trade increase income inequalities in capital abundant countries which support the HOS model.

The paper is organized as follows. Section 2 describes the empirical approach. Section 3 presents the construction and the robustness of our policy trade index in a gravity model, and section 4 presents the results and section 5 concludes.

## 2 Empirical approach

### *2.1 Usual test*

Several studies (Table 1) test the hypothesis that greater openness reduces inequality in developing countries. To do so these studies introduce multiplicative variable between openness $Open_i$ and level of development $Y_i$ (quantitative: income per capita, or qualitative: dummy for OECD country). Hence they test if the impact of openness differs according to the level of development. They add also other control variables $Z_i$ (education, civil liberties…) (equation 1.1).

$$INEQ_{it} = \beta_0 + \beta_1 Y_{it} + \beta_2 Open_{it} + \beta_3 (Open_{it} * Y_{it}) + \beta_4 Z_{it} + \varepsilon_{it} \quad (1.1)$$

This hypothesis is derived from the basic HOS with two factors in which developing countries have an abundant supply of unskilled labor relative to skilled labor and developed countries have an abundant supply of skilled labor relative to unskilled labor. The support for the hypothesis is that $\beta_1$ is negative and $\beta_2$ is positive.

**Table 1: Studies on Openness and Inequality**

| Study on Gini | Sample | Measure of openness | Effect of openness on inequality |
|---|---|---|---|
| Edwards 1997 | 43 countries in 1970 and 1980<br>by decade averages<br>First difference | Tariffs, Sachs - Warner, Adjusted Trade | =0 for developed countries<br>=0 for developing countries |
| Savvides 1998 | 34 countries on 1978-1994 in two periods<br>First difference | Tariffs and NTBs, Sachs -Warner | =0 for developed countries<br>>0 for developing countries |
| Li, Squire and Zou 1998 | 49 countries on 1960-1990<br>5 years period average<br>OLS | X/GDP | =0 |

| | | | |
|---|---|---|---|
| Higgins & Williamson 1999 | 85 countries on 1960-1990<br>Decades averages<br>OLS and Fixed Effect | Tariffs, NTBs, Sachs-Warner, Adjusted Trade | <0 for developed countries in OLS<br><0 for developing countries in OLS<br>=0 for developed countries in FE<br>=0 for developing countries in FE |
| Barro 2000 | 84 countries on 1960-1990<br>OLS and Fixed Effect | Adjusted Trade | <0 for developed countries in OLS<br>>0 for developing countries in OLS<br>>0 for countries in FE |
| Calderon and Chong 2001 | 102 countries on 1960-1995<br>5 years period average<br>GMM | Trade to Gdp ratio, Sachs-Warner, | <0 for developing countries<br>=0 for developed countries |
| Ravallion 2001 | 50 countries on 1947-1994<br>5 years period average<br>OLS | X/GDP | <0 for developed countries<br>>0 for developing countries |
| Rama 2001 | 97 countries on 1960-1990<br>period average<br>OLS | X+M/PIB | >0 for countries<br><0 for skill intensive countries |
| Dollar and Kraay 2002 | 92 countries on 1950-1999<br>Fixed Effect | Trade to Gdp ratio, Adjusted Trade, Sachs-Warner, Tax on imports | =0 for developed countries<br>=0 for developing countries |
| Milanovic 2002 | 83 countries in 1988, 1993 and 1998<br>OLS and GMM | Trade to Gdp ratio | >0 for poor countries<br><0 for middle income countries |
| Lundberg et Squire 2003 | 38 countries on 1960-1994<br>5 years period average<br>OLS and TSLS | Trade to Gdp ratio, Sachs-Warner | >0 |

Results (Table 1) are sometimes in accordance with the prediction (Calderon and Chong 2001), often non significant (Edwards 1997, Li, Squire and Zou 1998, Higgins and Williamson 1999, Dollar and Kraay 2002) or strictly contrary to the model (Savvides 1998, Barro 2000, Ravallion 2001, Rama 2001 and Milanovic 2002). We observe also that studies in OLS find mainly a result that does not support the HOS theorem whereas studies with fixed-country effects find no significant results.

### 2.2 *Heterogeneity among developing countries*

We need to account for heterogeneity among developing countries. Being a developing country does not mean having a comparative advantage in unskilled labor. Wood (1997) explains that trade liberalization

occurred in Latin American countries when they were less competitive for unskilled labor compared to Asian countries. Harrison and Hanson (1999) study the pattern of trade liberalization in Mexico in the 1980s. They conclude that tariffs fell most in sectors which had a higher share of unskilled worker, which explains the rise in wage inequality. In fact, protection was skewed towards low-skilled sectors prior to the reform, since Mexico did not have a comparative advantage in unskilled workers.

Some developing countries are also well-endowed in natural resources, often not equitably distributed in the population. Therefore the increase in the returns from this factor during trade liberalization could benefit few owners (Bourguignon and Morrisson 1990). Moreover the natural resource exploitation requires physical capital but not human capital. Therefore the exploitation of such comparative advantage could lead countries to neglect the construction of a sufficient human capital stock that could provide enough skilled workers during the emergence of the manufacturing industry (Leamer and al. 1999). Finally if trade liberalization encourages specialization towards primary commodities, it will increase the volatility of developing countries terms of trade, with the poor being more vulnerable to these shocks than the rich (Birdsall, 2002). This is the case especially for Latin American countries. Hence, as Spilimbergo and al (1999) and Fisher (2001) in Table 2, we test the hypothesis that the effect of greater openness on overall inequality vary, depending on factor endowments: in physical capital relative to labor, $RE_i^K$ , in skilled labor relative to labor, $RE_i^S$ , and in natural resources relative to labor, $RE_i^T$ (equation 1.2).

$$INEQ_{it} = \beta_0 + \beta_1 Open_{it} + \beta_2 RE_{it}^K + \beta_3 RE_{it}^T + \beta_4 RE_{it}^S + \beta_5 Open_{it} * RE_{it}^K + \beta_6 Open_{it} * RE_{it}^T + \beta_7 Open_{it} * RE_{it}^S + \beta_8 Z_{it} + \varepsilon_{it} \quad (1.2)$$

Since physical capital and natural resources are likely to be concentrated in the hand of few people because there is no natural upward limit to their accumulation we expect a positive sign of $\beta_2$ and $\beta_3$ as well as $\beta_6$ and $\beta_7$. In return, other factors such as human capital cannot be as concentrated because of the natural limit in the amount of education that an individual can accumulate, so we expect a negative sign for $\beta_4$. However an increase in its returns due to an increase in trade openness would increase income inequality since it concerns the richest people: $\beta_7$ positive.

**Table 2: Studies using Factor Endowment**

| | | | |
|---|---|---|---|
| Bourguignon and Morrisson 1990 | 35 developing countries in 1970 OLS | Tariffs on manufactured goods | <0 for developing countries |
| Leamer, Maul, Rodriguez and Schott 1999 | 84 countries in 1980 and 1990 decade averages | Net export ratios for specific products | >0 for primary products<br><0 for manufactured products |
| Spilimbergo, Londono Szekely 1999 | 34 countries on 1962-1994 OLS | Adjusted trade, Sachs Warner, black market premium | <0 for unskilled intensive countries<br><0 for capital intensive countries<br>=0 for land intensive countries (<0 for LDC) |
| Fisher 2001 | 66 countries on 1965-1990 5 years period average Fixed Effect | Sachs-Warner | <0 for unskilled intensive countries<br><0 for capital intensive countries<br>=0 for land intensive countries |

Regarding results (Table 2), in both cases, openness leads to more inequality and trade effects undo the direct effects of endowments (i.e. interaction coefficients have an opposite sign compared to direct effects). Some results are opposite to what the simple HOS framework would predict. In particular, both Spilimbergo and al. (1999) and Fisher (2001) find that the effect of openness decreases inequality as countries' endowment of capital increases, and that the effect of openness is unaffected by countries'

endowments of arable land per capita. However there is also qualified support for the HOS hypothesis. In particular, they also both find that openness increases inequalities as countries' endowment of human capital increases.

### *2.3 Different skill categories*

However we can be skeptic about the theoretical relationship between openness in human capital abundant countries and income inequalities. For Wood (1994), with three types of labor, the distributional impact of trade in developing countries is complex. A large part of the labor force in poor countries does not have any education, even basic, and is employed in the traditional craft sector or in non-tradable activities (e.g. services). It is strongly questionable whether their output corresponds to tradable goods, as far as manufacturing industries are concerned. Moreover their mobility toward the "modern" sector is hindered by the lack of basic education. Even in an economy where the export-oriented manufacturing sector is intensive in low-skilled labor, such non-educated workers are thus unlikely to receive any direct benefit from the development of the export sector or from an increase in the price of exports. The positive impact on the relative price of unskilled labor, admittedly considered as the abundant factor for developing countries, might thus be restricted, in practice, to a fraction of unskilled workers only, namely those enjoying at least basic education, and likely to work in the "modern" sector. As soon as the share of no-educated labor in the labor force is large enough, the alleged positive impact of trade openness on unskilled (but somewhat educated) labor does not reduce inequalities. On the contrary, the deterioration of the relative position of non-educated workers would increase income inequalities. Hence openness to trade in poor countries might increase inequalities by helping those with basic education and leaving even further behind those with no education.

The study by Bensidoun and al. (2005) tests the assumption that the share of non educated labor could explain why trade liberalization increase income inequalities in some developing countries. They firstly show that, on average, international trade led to a widening of income inequality both in poor and rich countries, and to a reduction in middle-income countries. In their model, exporting firms require at least some education from their workers that trade does not directly benefit workers without any education, so that international trade leads to rising inequalities for countries with a high share of no educated people. However they say nothing about primary educated labor and the highly skilled labor, and they do not measure the trade policy but only the change in the factor content of trade flows.

### *2.4 Differences in natural resource abundance*

As to remaining endowments, Wood (2003) suggests that arable land per worker (as in Spilimbergo and al. (1999), Fisher (2001) or Leamer and al. (1999)) is not sufficient to encompass natural resources and suggests using land per worker. Whereas arable land per worker captures factor intensities in the production of food and raw materials, it does not include mining and fuel which are the less equally-distributed resources. This may explain why several studies find that endowments in arable land increases inequality during trade liberalization (e.g. Spilimbergo et al. (1999) and Perry and Olarreaga (2006)). Our preferred specification uses an indirect measure of endowments in mining and fuel captured by net exports if those products, next to the measure of arable land.

## 3 Measure of openness through a gravity model

### *3.1 Which sort of index for openness?*

The simplest approach is to use the ratio of total trade (exports plus imports) to total output for each economy as a measure of trade policy "openness." This has the advantage of being easily computed from available data for a broad range of nations over long periods of time, and it may be an appropriate indicator of an economy's overall exposure to international markets, but it is a poor measure of comparative trade policy orientation. A great deal of the cross-national variation in the extent to which nations trade is due to geographical factors, such as their distance from major markets, and their size. Existing measures of the degree to which governments restrict trade generally fall into two types: measures of the incidence of trade restrictions and measures of their effects on outcomes.

Incidence-type measures assess the height or coverage of various tariff and non-tariff trade distortions. Unfortunately, the average tariff is not a very reliable comparative measure of trade restrictions since it cannot simply be assumed that the same tariff levied on different products and in different economies will have the same restrictive effect (i.e., that import elasticities are identical across all products and economies and the structure of protection in each economy is inconsequential). Moreover, the data are not available through a large period and to use it would lead us to restrict our period under analysis to 1980-2000. Most importantly, of course, tariff-based measures ignore non-tariff forms of protection, which have become increasingly important as policy instruments for governments in both advanced and developing economies (Kee, Nicita and Olarreaga (2004)). Finally, in using tariffs we only include the unilateral liberalization side, i.e.

the fact that a country liberalizes the importations. And in a context of trade liberalization for developing countries we are interested in their access to other markets through their exports. Recently, Mayer and Zingaro (2004) show that the access to developed countries was heterogeneous among developing countries.

Given the severe problems associated with measuring and comparing tariffs and NTBs, several analysts have relied instead upon outcome-based indicators of trade restrictions. Some have focused on price outcomes as Edwards (1993) and Dollar (1992). But alternative sources of variation in black-market currency prices and goods prices pose major problems for these measures, and reliable comparative data on prices of both types are quite limited. Outcome-type measures assess the difference between some quantities and the outcomes that would be predicted in the absence of trade restrictions. These measures capture also the implicit protection through substitutes (including domestic policies adopted) of standard trade policy measures that governments use after commitment to tariff levels in international agreements.

There have been very few attempts to adjust openness measures to take into account cross-national differences in geographical variables and resource endowments. Most notably Leamer (1988) has estimated net exports for 53 nations in 182 commodity categories in 1982 as a function of each nation's relative endowments of different types of factors of production and computed a measure of trade openness for each nation by summing the deviations between predicted and actual net exports across commodity categories. The approach is extremely data intensive, however, and even so the model produces such large residuals when used to predict export flows that Leamer himself finds it difficult to attribute them wholly to trade barriers (1988). Pritchett (1996) has tried a slightly different

approach, estimating the ratio of trade to GDP as a function of population, area, and GDP per capita for 93 nations in 1985, using the residuals as a measure of trade openness. Spilimbergo, Londono, and Szekely (1999) have created a similar measure by estimating total trade as a percentage of GDP for a panel of 34 nations between 1965 and 1992 using population, income, distance from major markets, and the distinctiveness of each nation's factor endowments relative to world endowments, on the right-hand side.

While these are useful extensions of Leamer's approach that account for more of the variables (apart from policy) that explain trade flows, it seems a major less efficient to apply the gravity model to predict aggregate openness ratios for each country rather than applying it to bilateral trade flows where it has proven to be very effective. This approach was firstly used by Hiscox and Kastner (2002) for 82 countries between 1960 and 1992 in a model where they included income, distance and the difference in factors endowments. We extend their measure by including more countries on a larger period and in accounting for size of countries, difference in human capital and mineral/fuel resources endowments and remoteness.

### *3.2 A Gravity model to measure Openness*

The basic gravity model posits that the volume of trade between two nations is an increasing function of the incomes of those nations and a decreasing function of the distance between them. It is well known that richer countries tend to be more open, while larger countries tend to be less open. Although we include other variables, including whether the countries share a common border and/or a common language are often added to the model. The model has proved to be an extremely effective framework for gauging what patterns of trade are normal or natural among

nations (Frankel and Wei 1993, Baier and Bergstrand 2001). Frankel and Romer (1999) use it to estimate the natural openness in a country. By implication, the model should also be able to help us in identifying abnormal or distorted patterns of trade and estimating the extent to which these are due to the trade policies of particular nations. The basic form of the gravity model can be expressed in log-linear form as

$$\ln\left(\frac{(M+X)_{ijt}}{Y_{it}}\right) = \alpha_{it} + \beta_1 \ln Y_{jt} + \beta_2 \ln(P_{it} * P_{jt}) + \beta_3 Dist_{ijt} + \beta_4 Z_{ij} + \varepsilon_{it} \qquad (2.1)$$

Where $(M+X)_{ijt}$ represents total trade flow between country *i* and *j*, $Y_{it}$ and $Y_{jt}$ denote national income, $P_{it}$ and $P_{jt}$ are total population, $Dist_{ijt}$ is the distance between economic centers of each country. $Z_{ij}$ represents dummies including whether the countries share a common border and/or a common language, are landlocked or exporter of oil.

In order to evaluate the distorting effects of each country's policies in each year we include a country year dummy $\alpha_{it}$ for country *i* in year *t*. The country-year dummy variables stand in for the (unmeasured) relative openness of trade policy orientations. A similar approach has been used to gauge the effects of regional trade agreements on trade flows by using dummy variables for pairs of nations in the same regional bloc as a proxy for regionally specific discriminatory policies. Here the set of estimated coefficient $\alpha_{it}$ provides the amount of trade flows due to distorting effects of each country's policies in each year when compared to the mean for the entire sample.

A key problem here is that we cannot distinguish between the effects of changes in trade policies and other changes, specific to particular

importing countries in particular years, that also affect trade flows and are not accounted for in the model. The Heckscher-Ohlin (HO) model of trade suggests that trade flows should vary with the character of each nation's factor endowments relative to that of its trading partners. That is why we include variables that represent differences in factor endowments between countries. Moreover since we use the index in a second step (impact of trade openness on income inequalities) where those factor endowments variables are included we have to include them in this first step.

$$\ln\left(\frac{(M+X)_{ijt}}{Y_{it}}\right) = \alpha_{it} + \beta_1 \ln Y_{jt} + \beta_2 \ln(P_{it} * P_{jt}) + \beta_3 Dist_{ijt} + \beta_4 \ln K_{ijt} + \beta_5 \ln N_{ijt} + \beta_6 \ln T_{ijt} + \beta_7 \ln H_{ijt} + \beta_8 Z_{ij} + \varepsilon_{it} \quad (2.2)$$

Where $K_{ijt}$, $N_{ijt}$, $T_{ijt}$ and $H_{ijt}$ are differences in factor endowments between countries *i* and *j* in physical capital per labor, mineral/fuel resources per labor, arable land per labor and human capital per labor.

We include also remoteness since a country's trade with any given partner is dependent on its average remoteness to the rest of the world (Anderson and Van Wincoop 2003). Hiscox and Kastner (2002) did not account for this multilateral resistance to trade. For example, Australia and New Zealand trade more with each other than they would if other large markets were nearby[26]. Studies that do not control for remoteness produce biased estimates of the impact of trade policy on trade. Let $R_i$ and $R_j$, denote the remoteness of j and i, equal to GDP-weighted of distance.

[26] Austria and Spain trade less each other than Australia and New Zealand although they are separate by equal distance, because they have other closer market around them.

$$\ln\left(\frac{(M+X)_{ijt}}{Y_{it}}\right) = \alpha_{it} + \beta_1 \ln Y_{jt} + \beta_2 \ln(P_{it} * P_{jt}) + \beta_3 Dist_{ijt} + \beta_4 \ln K_{ijt} + \beta_5 \ln N_{ijt} + \beta_6 \ln T_{ijt} + \beta_7 \ln H_{ijt} + \beta_8 \ln(R_{it} * R_{jt}) + \beta_9 Z_{ij} + \varepsilon_{it} \quad (2.3)$$

The data set is a panel of bilateral trade flows for 91 countries over the period 1960-2000 taking five years average periods to exclude problems of volatility. The data on trade flows come from Andrew Rose (2004) based on the CD Rom "Direction of Trade" from IMF. The measure of income is the real GDP in 1995 dollar from WDI (2004). The distance's measure comes from CEPII. The measure on capital per worker comes from Easterly and Levine (1999) and Kraay and al. (2000), the measure on arable land par person comes from WDI (2004) and the average years of schooling in the population over 15 years old comes from the Barro and Lee (2000) database. The measure for mining and fuel resources is the index from Isham and al. (2005) base on net exports share on fuels and minerals (see Appendix).

To check the robustness of our approach, we also estimate the model on imports to country *i* from *j* and on exports to country *i* to *j*. So we have three estimations in OLS (Table 3) where the first column deals with total trade flows (imports and exports), column (2) deals with exports flows and column (3) with imports flows.

The model performs well, variables are almost all significant and give expected results. The income of partner country is strongly positively significant and close to 1. The sign concerning the size of countries and the distance are strongly negatively significant. The estimated coefficients for each endowment variables correspond broadly to theoretical expectations. This shows us the importance of these determinants in trade patterns. The trade flows are always lead by differences in factor endowments. For the

three estimations, we extract the estimated coefficient for the set of country-year dummy variables $\alpha_{it}$. These estimated coefficients are reported as differences from the sample mean intercept. To the extent that other determinants are controlled for, these estimates represent the estimated amounts (in logs) by which real trade flows are altered by unobservable aspects (i.e., policies) of the importing country *i* in year *t*, compared to the mean country-year, all else equal. Large positive values represent relatively open trade policy orientations, while large negative values represent relatively closed or protectionist policy orientations.

**Table 3 : Gravity model : Estimate of Openness**

| | **Trade (Xij+Mij)/GDPi** | | **Export Xij/GDPi** | | **Import Mij/GDPi** | |
|---|---|---|---|---|---|---|
| | **1** | | **2** | | **3** | |
| Income of country j | 0.9159 | 157.43 | 0.8966 | 130.18 | 1.0444 | 154.98 |
| Population of country i and j | -0.1095 | -11.52 | -0.0643 | -5.65 | -0.1640 | -14.94 |
| Distance between i and j | -1.2357 | -87.84 | -1.3229 | -80.69 | -1.2867 | -76.66 |
| Diff in Ar.Land per labor ratio | 0.1651 | 22.27 | 0.1446 | 16.06 | 0.2094 | 22.30 |
| Diff in Min-Oil per labor ratio | 0.0359 | 4.37 | 0.0447 | 4.72 | 0.0173 | 1.78 |
| Diff in Capital per labor ratio | 0.0305 | 3.68 | 0.0322 | 3.23 | 0.0244 | 2.69 |
| Diff in Education per labor ratio | 0.0933 | 4.45 | 0.1008 | 4.39 | 0.0823 | 3.33 |
| Remoteness of country i and j | 0.5132 | 11.44 | 0.2649 | 4.81 | 0.9743 | 18.15 |
| Common Border | 0.3833 | 6.58 | 0.4348 | 6.32 | 0.5356 | 7.86 |
| Colonial relationship | 1.1872 | 27.72 | 1.3090 | 25.90 | 1.2707 | 25.71 |
| Common colonist | 0.8158 | 17.16 | 0.7295 | 13.35 | 0.8405 | 15.45 |
| Common Language | 0.4094 | 16.56 | 0.4540 | 15.72 | 0.4268 | 14.84 |
| Current colonial relation | 0.5259 | 3.02 | 0.5503 | 2.36 | 0.6753 | 3.30 |
| Landlockness | -0.0237 | -0.93 | -0.2162 | -7.10 | -0.2167 | -6.87 |
| Island | -0.4578 | -12.60 | -0.6110 | -16.05 | -0.2050 | -4.89 |
| $R^2$ | 0.74 | | 0.65 | | 0.66 | |
| Observations | 36 096 | | 39 867 | | 39 867 | |

The t- student appear in bracket

### *3.3 Robustness test of the gravity-based index*

The new estimates compare very favorably with alternative measures of trade policy orientations. Table 4 reports coefficients of correlation with the most commonly used measures of trade openness or protection over all samples for which these alternatives are available. We choose the usual trade ratio(X+M)/PIB, the weighted tariffs from WDI (2004), the tax on inputs and capital from Barro and Lee (2002). We add outcome-based indicators of trade restrictions, Leamer (1988), Dollar (1992), Prichett (1996), Spilimbergo and al. (1999) and Hiscox and Kastner (2002). We include our three measures of the index from the estimations in Table 3, on the total trade (row 6), on import (row 7) and on exports (row 8).

**Table 4: Correlation of gravity-based index with other indexes**

| | | Tariffs World Bank | Tariffs Barro Lee | Index Leamer | Index Dollar | (X+M)/ GDP | Index Prichett | Index Spilimb | Hiscox Karstner |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Observations | 241 | 109 | 38 | 123 | 241 | 241 | 241 | 241 |
| 2 | (X+M)/GDP | -0.17* | -0.32* | 0.77* | 0.16 | 1.00 | | | |
| 3 | Index Prichett | -0.01 | -0.09 | 0.42 | 0.03 | 0.63 | 1.00 | | |
| 4 | Index Spilim | -0.14 | -0.22 | 0.40 | 0.07 | 0.56* | 0.81* | 1.00 | |
| 5 | Hiscox Karstner | 0.46* | 0.55* | -0.58 | -0.25 | -0.39* | -0.11 | -0.15 | 1.00 |
| **6** | **Index Trade** | **-0,43*** | **-0,41*** | **0,71*** | **0.24** | **0.52*** | **0.39*** | **0.44*** | **-0.47*** |
| **7** | **Index Import** | **-0.52*** | **-0.45*** | **0.39** | **0.20** | **0.27** | **0.06** | **0.23*** | **-0.62*** |
| **8** | **Index Export** | **-0.45*** | **-0.25*** | **0.73*** | **0.04** | **0.43*** | **0.29*** | **0.30*** | **-0.39*** |

*means significant at 1%.

Our measure of trade openness on imports (row 7) is strongly negatively correlated with the tariffs barriers in imports (column 1, 2 and 8). The measure of openness in exports (row 8) is strongly positively correlated with outward oriented index (column 3 to 7). Measure of openness based on total trade (row 6) usually has the highest correlation with the other indices. The country case studies in Annex 4 show us the change in index (Index Trade) , ranked from 0 to 10, through time for different countries. We observe the increase in trade openness for Latin American countries

since 1990 as well are their lag compared to East Asian countries (except for Chile which had liberalized sooner).Singapore and Hong Kong reach the highest scores and we observe the increase in trade liberalization for Korea in the seventies. For the further parts of the study we will keep the "Index Trade" measure which we will call thus Trade Openness Index (TOI).

## 4 Trade openness and income inequality

### *4.1 Data and econometric specifications*

Gini coefficients come from the Wider (2004) database. We use dummy variables to control the sources of data: gross income or net income, income or expenditure and households or individuals[27]. Factor intensity in a country is often measured as factor intensity in a sector, by a ratio of the factor on labor. Indeed, it is more suitable to use a ratio of per capita endowment of a factor in the country on the world per capita endowment in this factor as we deal about relative advantage in factor endowment. We use the formula constructed by Spilimbergo and al. (1999). The ratios are weighted by the degree of openness to account for the endowments of closed countries that do not compete in the world markets with other factors (see annex). We include the Kuznets curve with the income per capita in parity purchase power in linear and squared form. We exclude countries from ex-USSR. The sample for our preferred approach, where we need at least two observations per country to use fixed country effects, concerns 71 countries for 307 observations (51 developing countries give 208 observations and 20 developed countries give 99 observations) in five years averages on 1970-2000 (Annex 1).

[27] Some records are based on expenditure surveys and other on income surveys, and we know that inequality in income is highest than inequality in expenditures.

We present different econometric specifications. Firstly we present the OLS estimations on pooling frequently used in this empirical literature to get the same results than Spilimbergo and al. (1999). Secondly, in order to account for the panel dimension of our panel and for the heteroskedasticity[28] we report panel-corrected standard errors. But trying to explain cross-country differences in levels of inequality is not easy, since a number of factors cannot be properly taken into account. Fiscal redistribution, ethno linguistic fragmentation or distribution of factor ownership, for instance, are not well documented for most countries. As a consequence, econometric estimates are likely to be flawed with omitted variable bias. In addition, the interesting issue from a policy perspective is not whether countries with different degrees of openness exhibit different levels of inequality, but rather whether an increase in a country's trade openness is associated with an increase or a decrease in inequality. Hence, thirdly we use a within-estimator and we include country-specific effects to account for countries' heterogeneity. However, this will lead us to loose some information notably concerning the effect of factors endowments.

We use lagged variable concerning openness and interaction of openness with endowments to control for endogeneity between trade policy and income distribution. Lundberg and Squire (2003) argue that Dollar and Kraay (2002) dismiss endogeneity concerns when they affirm that the share of income accruing to the poor is unlikely to have any

[28] The Breusch Pagan test and the White test indicate heteroskedasticity in the error process ($\sigma^2_{it} \neq \sigma^2$). We carried out our estimates using two estimators: the standard heteroskedasticity-consistent White (1984) estimator and the panel-corrected standard errors (PCSEs) estimator proposed by Beck and Katz (1995) which is shown to be as good or slightly superior to the robust estimator in Monte-Carlo studies for small samples (see Beck and Katz (1996, table 2). Since both estimators give very similar results, in subsequent tables we only report results based on PCSEs.

influence on policies that affect the overall growth rate[29]. In fact, Persson and Tabellini (1994) find that the position of the median voter, relative to the mean of the income distribution, is a good predictor of the demand for policies that can influence growth or distribution. In such a case, these policies, including openness, are correlated with the error term. Moreover all this lagged variables need times to affect income distribution. So we lag also the endowment variables all the more so since they can be affected also by income inequality notably concerning human capital endowment. Since we use a generated variable (i.e. the policy trade index), we have to recalculate all the standards errors of the variables, we use the bootstrap technique to estimate standard errors and to construct confidence intervals[30].

Finally, while the possibility of a spurious relation still persists, one of the strong candidates for the observed relation would be that changes in inequality due to a successful stabilization policy would be attributed to increased openness because of a positive correlation between trade liberalization and concurrent stabilization policies (trade liberalization often occurs during periods of systemic reforms including macro stabilization). We include the inflation to capture effects of macro stabilization not due to trade openness.

[29] "Since these other policies and institutions are changing over time, their influence on the included variables cannot be removed simply by differencing" [Lundberg and Squire (2003), p. 340]

[30] For a generated variable, the confidence interval in the second step is not correct as it refers to the first step. So we built a sampling distribution based on the initial sample from which repeated sample are drawn to obtain a correct distribution and correct standards errors.

### *4.2 Extensions of previous results*

For the sake of comparison (and to see what is driving the difference in results), we start in table 5 with a replication of the estimates carried out by Spilimbergo et al. (1999) on our data set by using their openness index (equation 1.2).

$$INQ_{it} = D_i + \alpha_1 \overline{Y}_{it} + \alpha_1 \overline{Y^2}_{it} + \beta_1 Open_{it} + \sum_{f=1,3} \phi_f RE_{ift} + \sum_{f=1,3} \phi_{2f} (Open_{it} * RE_{ift}) + \sum_l \delta_l Z_{it} + \sum_{k=1,3} \gamma_k DS_{ikt} + e_{it} \quad \text{i=1,....,75 ; t=1,...,8} \tag{3.1}$$

In (3.1), the index of inequality is regressed on a set of country dummies $D_i$, on income per capita measured in PPP, $\overline{Y}_{it}$, on its squared form $\overline{Y^2}_{it}$ (for Kuznets relation) , on trade openness $Open_{it}$ and on relative endowment $RE_{ift}$ in three factors, human capital (ED/L), arable land (AT/P) and physical capital (K/L). We test the impact of trade openness $Open_{it}$ according to relative endowment $RE_{ift}$ in the three factors.

We add dummy variables, $DS_{ikt}$, to control for the source of inequality data (dummy variables for gross vs. net income, income vs. expenditure, and households vs. individuals), and on a set of control variables, $Z_{it}$. All the variables are expressed in logarithms. As mentioned above, all data are five year averages (this helps to control for autocorrelation and measurement error), giving us eight observations across time. The sample is restricted to observations which provide both Spilimbergo and al. Index (SI) and our Trade Openness Index (TOI) in order to get the same sample of observations and we drop countries which have less than two observations to get the same sample between OLS and within estimators .

The first column in table 5 implements the specification with an OLS estimator in pooling and with their adjusted trade ratio (SI) we add dummies for Latin American countries and African countries which present high Gini values. All the OLS estimations present robust standard errors. As expected we find their results: trade openness raises inequality for skilled abundant countries (as in HOS framework) but decreases inequality for capital and natural resources abundant countries which does not support the HOS framework. In column (2) we use lagged variables to control for endogeneity and the previous results remain. In the column (3), we add dummy variables to control for data sources. This reduces some coefficient values concerning interaction, but all remain significant.

Column (4) present the within estimator and column (5) introduces the panel corrected standard errors to correct for heteroskedasticity in our coefficient and not only in our variances. We see that except for the human capital endowment, none of previous results holds, particularly the effect for capital abundant countries which seemed so robust without accounting for countries heterogeneity. Columns (6) and (7) present our own trade policy indicators (TOI), and in column 7 we include inflation. The results show that our index does not confirm previous results since the index of openness is no longer associated with income inequality. Thus table 5 tells us that accounting for heterogeneity across countries changes the results and the measure of openness is crucial in the interpretation of the results. The results do not confirm earlier findings (e.g. Dollar and Kraay (2002), Edwards (1997)), since a reduction in inflation does not reduce significantly inequality. The Kuznets relation is not stable across specifications, the turning point is very weak in OLS specifications (around 2 500$ per capita) and most reliable in fixed effects (around 9 000$).

**Table 5: Inequality and Openness: comparison across openness Indices**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| | OLS | OLS | OLS | FE | FE(PCSE) | FE(PCSE) | FE(PCSE) |
| Index of openness | SI | SI | SI | SI | SI | TOI | TOI |
| | Ln Gini | Ln Gini | Ln Gini | Ln Gini | Ln Gini | Ln Gini | Ln Gini |
| Ln GDP/capita | 0.5121b | 0.6572a | 0.7779a | 0.5582c | 0.5582b | 0.7507b | 0.7556b |
| | (2.21) | (3.36) | (3.84) | (1.87) | (2.53) | (2.48) | (2.49) |
| Ln (GDP/capita)² | -0.0329b | -0.0422a | -0.0499a | -0.0302c | -0.0302b | -0.0407b | -0.0408b |
| | (2.50) | (3.73) | (4.27) | (1.80) | (2.43) | (2.26) | (2.27) |
| Ln $AT/P_{t-5}$ | 0.0381 | 0.0720b | 0.0775a | -0.0009 | -0.0009 | -0.0383 | -0.0387 |
| | (1.34) | (2.49) | (2.75) | (0.01) | (0.02) | (0.52) | (0.52) |
| Ln $K/L_{t-5}$ | 0.1995a | 0.2014a | 0.1635a | -0.0325 | -0.0325 | -0.0070 | -0.0103 |
| | (3.57) | (4.15) | (3.16) | (0.69) | (0.86) | (0.18) | (0.25) |
| Ln ED $/L_{t-5}$ | -0.2763a | -0.3157a | -0.2319a | -0.3580a | -0.3580a | -0.2390a | -0.2384a |
| | (2.87) | (5.22) | (3.76) | (5.28) | (6.97) | (3.22) | (3.22) |
| $Ouverture_{t-5}$ | 0.0200a | 0.0150b | 0.0152b | 0.0157 | 0.0157b | -0.0186c | -0.0187c |
| | (3.14) | (2.32) | (2.31) | (1.48) | (2.01) | (1.69) | (1.70) |
| Ln $AT/P_{t-5}$*$Ouv_{t-5}$ | -0.0065c | -0.0117a | -0.0114a | -0.0043 | -0.0043 | 0.0059 | 0.0059 |
| | (1.74) | (2.93) | (2.86) | (0.59) | (0.78) | (0.74) | (0.75) |
| Ln $K/L_{t-5}$*$Ouv_{t-5}$ | -0.0307a | -0.0314a | -0.0231a | 0.0009 | 0.0009 | 0.0017 | 0.0019 |
| | (3.52) | (4.47) | (3.05) | (0.15) | (0.20) | (0.19) | (0.22) |
| Ln $ED/L_{t-5}$*$Ouv_{t-5}$ | 0.0381b | 0.0507a | 0.0315a | 0.0477a | 0.0477a | 0.0327c | 0.0329c |
| | (2.37) | (4.52) | (2.60) | (3.56) | (5.01) | (1.91) | (1.92) |
| Ln Inflation | | | | | | | 0.0080 |
| | | | | | | | (0.81) |
| Gross/Net Income | | | 0.0476b | 0.0050 | 0.0050 | 0.0013 | 0.0015 |
| | | | (2.37) | (0.19) | (0.28) | (0.07) | (0.08) |
| Income/Expenditure | | | 0.0816a | 0.0843a | 0.0843a | 0.0839a | 0.0877a |
| | | | (3.33) | (2.68) | (3.15) | (3.25) | (3.14) |
| Households/Individuals | | | 0.0361c | 0.0361b | 0.0361a | 0.0345b | 0.0346b |
| | | | (1.95) | (2.20) | (2.80) | (2.47) | (2.48) |
| SSA | 0.2910a | 0.2869a | 0.2525a | | | | |
| | (12.06) | (13.17) | (10.71) | | | | |
| LAC | 0.2915a | 0.2954a | 0.3039a | | | | |
| | (8.22) | (9.16) | (10.14) | | | | |
| Fixed Effects | No | No | No | Yes | Yes | Yes | Yes |
| Constant | 1.5394 | 1.0134 | 0.4593 | 0.6791 | 0.6791 | 0.3310 | 0.2845 |
| | (1.52) | (1.19) | (0.52) | (0.50) | (0.67) | (0.26) | (0.22) |
| Observations | 304 | 333 | 333 | 333 | 333 | 333 | 333 |
| R-squared | 0.58 | 0.60 | 0.64 | 0.20 | | | |
| | | | | (0.88*) | | | |
| Number of countries | 75 | 77 | 77 | 77 | 77 | 77 | 77 |

All the estimations present robust standard errors. Absolute value of z statistics in parentheses

c significant at 10%; b significant at 5%; a significant at 1%. * with fixed country effects

### *4.3 Adding different skill categories and accounting for mineral/fuel resources*

*Land and Natural Resources*

Arable land per person (AT/P) is not a good proxy for natural resources as it does not include endowments in mining and fuels resources, which are theoretically more unequally distributed than arable land. This might explain why previous studies do not find that openness increases inequality for natural resources abundant countries since they used arable land to measure it. Hence Wood (2003) suggests to use land (T/P) and not arable land (specific to agriculture) in order to include mineral and fuel resources. An alternative is to use the index from Isham and al. (2005) based on net exports shares to approximate the endowment in mining and fuels resources (MF/L). We use arable land on labor force (AT/L) and not population as done in previous studies.

*Different skill categories*

Our model assumes that it might be fruitful to break-down unskilled labor into non-educated and primary-educated as suggested by Wood (2002) and done recently in Bensidoun et al. (2005) in a slightly different context.[31] This leads us to a specification in which we replace the index of human capital (ED/L) (average years of schooling) endowment by different categories of skill level. We include no-educated (NO-ED/L) (those that have never been to school and those that have not completed primary school), based-educated (BS-ED/L) (primary-school completion and those that have not completed secondary school) and highly educated (SK-ED/L) (beyond secondary education). Our preferred specification includes the three

[31] They did not test the impact of trade liberalization but the impact of trade flows, and they just test for the no educated category. Moreover their sample is more restricted concerning the developing countries (it did not include sub Saharan African countries).

categories in only one estimation in using a pair of ratios: (SK-ED/BS-ED) and (SK+BS)/NO-ED.

So we re-estimate equation 3.1 by adding an index of endowments in mining and fuels (MF/L) and three different levels of education: (NO-ED/L), (BS-ED/L) and (SK-ED/L).

$$INQ_{it} = D_i + \alpha_1 \overline{Y}_{it} + \alpha_1 \overline{Y^2}_{it} + \beta_1 Open_{it} + \sum_{f=1,6} \phi_f RE_{ift} + \sum_{f=1,6} \phi_{2f} (Open_{it} * RE_{ift}) + \sum_{l} \delta_l Z_{it} + \sum_{k=1,3} \gamma_k DS_{ikt} + e_{it} \qquad \text{i=1,...,75 ; t=1,...,8} \tag{3.2}$$

Results with the 'augmented' endowment specification are reported in table 6. In column 1 we include labor with no education (NO-ED)/L. The results show that trade liberalization increases income inequality more for countries abundant in NO-ED. The threshold indicates that this effect occurs in countries with more than 68% to 50% of no-educated labor (the variation in the threshold is due to the variation in world endowment through time, see figure 1). The results also suggest that trade liberalization raises inequality more for capital abundant countries, which conforms to HO predictions, again a result that eluded previous studies.

As expected, replacing in column 2 (NO-ED)/L by the primary-educated ratio, (BS-ED)/L, reverses the results: trade liberalization decreases inequality for primary-educated abundant countries if indeed they represent a large share of poor. Here the threshold effect appears when the share of primary educated labor is greater than 20%. Again, as expected by HO theory, trade liberalization increases inequality in capital abundant countries. Robustness to HO predictions still holds when one replaces the primary educated, (BS-ED)/L, by the highly-educated, (SK-ED)/L, in column 3 as trade liberalization increases inequality in highly-

**Table 6: Inequality, skill categories and openness**

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| | FE(PCSE) Ln Gini | FE(PCSE) Ln Gini | FE(PCSE) Ln Gini | FE(PCSE) Ln Gini | FE(PCSE) Ln Gini |
| Ln $(AT/L)_{t-5}$ | -0.0328 | -0.0497 | -0.0623 | -0.0721 | -0.0444 |
| | (0.43) | (0.64) | (0.83) | (1.00) | (0.58) |
| Ln $(MF/L)_{t-5}$ | | | | | -0.3582a |
| | | | | | (3.30) |
| Ln $(K/L)_{t-5}$ | -0.0103 | 0.0033 | 0.0295 | 0.0199 | -0.0279 |
| | (0.30) | (0.10) | (0.87) | (0.51) | (0.64) |
| Ln $(NO\text{-}ED/L)_{t-5}$ | -0.1076 | | | | |
| | (1.35) | | | | |
| Ln $(BS\text{-}ED/L)_{t-5}$ | | 0.0284 | | | |
| | | (0.58) | | | |
| Ln $(SK\text{-}ED/L)_{t-5}$ | | | -0.0262 | | |
| | | | (0.75) | | |
| Ln $(SK+BS/NO\text{-}ED)_{t-5}$ | | | | 0.0401 | 0.0146 |
| | | | | (1.13) | (0.39) |
| Ln $(SK\text{-}ED/BS\text{-}ED)_{t-5}$ | | | | -0.1208a | -0.0672 |
| | | | | (3.06) | (1.57) |
| $Openness_{-5}$ | -0.0069 | -0.0131 | -0.0141 | 0.0026 | 0.0034 |
| | (0.70) | (1.31) | (1.33) | (0.46) | (0.51) |
| Ln $(AT/L)_{t-5}$*$Op_{t-5}$ | 0.0085 | 0.0095 | 0.0108 | 0.0121 | 0.0077 |
| | (1.10) | (1.16) | (1.34) | (1.59) | (0.94) |
| Ln $(MF/L)_{t-5}$*$Op_{t-5}$ | | | | | 0.0616b |
| | | | | | (2.45) |
| Ln $(K/L)r_{t-5}$*$Op_{t-5}$ | 0.0123c | 0.0110c | -0.0026 | 0.0082 | 0.0129c |
| | (1.81) | (1.76) | (0.34) | (1.09) | (1.79) |
| Ln $(NO\text{-}ED/L)_{t-5}$*$Op_{t-5}$ | 0.0274c | | | | |
| | (1.77) | | | | |
| Ln $(BS\text{-}ED/L)_{t-5}$*$Op_{t-5}$ | | -0.0163c | | | |
| | | (1.74) | | | |
| Ln $(SK\text{-}ED/L)_{t-5}$*$Op_{t-5}$ | | | 0.0146c | | |
| | | | (1.72) | | |
| Ln $(SK+BS/NO\text{-}ED)_{t-5}$*$Op_{t-5}$ | | | | -0.0171b | -0.0118c |
| | | | | (2.02) | (1.87) |
| Ln $(SK\text{-}ED/BS\text{-}ED)_{t-5}$ *$Op_{t-5}$ | | | | 0.0263b | 0.0170b |
| | | | | (2.54) | (1.97) |
| Ln Inflation | 0.0025 | 0.0042 | 0.0060 | -0.0061 | -0.0035 |
| | (0.26) | (0.41) | (0.61) | (0.64) | (0.35) |
| Gross/Net Income | 0.0033 | 0.0034 | -0.0057 | 0.0051 | 0.0063 |
| | (0.18) | (0.19) | (0.31) | (0.31) | (0.37) |
| Income/Expenditure | 0.0459a | 0.0480a | 0.0519a | 0.0392a | 0.0414a |
| | (3.16) | (3.47) | (3.66) | (2.92) | (2.78) |
| Households/Individuals | 0.0886a | 0.0874a | 0.0955a | 0.0708a | 0.0811a |
| | (3.52) | (3.30) | (3.84) | (2.87) | (3.04) |
| Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Observations | 307 | 307 | 307 | 307 | 282 |
| Number of countries | 71 | 71 | 71 | 71 | 66 |

c significant at 10%; b significant at 5%; a significant at 1%

educated abundant countries, though significance is decreased probably because of the high correlation (of 0.83) between high-skill educated (SK-ED) and capital (K/L). Here it seems that trade openness increases inequalities for countries with more than 10 to 30% of highly educated people, but the threshold is not robust enough to be reliable.

As shown in table 6, a convenient way to include these three levels of education is in ratio form: (SK-ED)/(BS-ED) and (SK+BS)/(NO-ED)[32]. We expect that during a trade liberalization, countries with a relatively (to the sample average) strong endowment in (SK-ED)/(BS-ED) to experience an increase in inequality, while, after having controlled for skill endowments, we would expect that countries relatively well-endowed in (SK+BS)/(NO-ED) would experience a decrease in inequality during a trade liberalization. Though weaker, the pattern of results still holds when we include two kinds of skills , (SK+BS)/(NO-ED) and (SK-ED)/(BS-ED) in column 4 both of which enter with the expected signs (a strong endowment in (SK-ED)/(BS-ED) is associated with more inequality while the opposite holds for (SK+BS)/(NO-ED). In column 5, we reintroduce (AT/L) but add mining and fuel (MF/L). With this preferred specification, trade liberalization does not impact on income inequality in countries well-endowed in arable land while it increases inequality in countries well endowed in mining and fuel, results echoing those Perry and Olarreaga (2006).

The figure 1 shows us the evolution of threshold values through time based on specification in columns 1, 2 and 3. Effectively since the world endowment change during the period under cover, the share of non educated (NO-ED), primary educated (BS-ED) and highly educated (SK-ED) that leads to a change in the impact of trade openness on specialization

[32] Thanks to Adrian Wood for this suggestion.

and factors returns move through time[33]. Here we see that in the sixties trade liberalization decreases inequalities for countries having less than 68% of non educated people, or about less than 10% of highly educated people or more than 20% of primary educated people. In the nineties, with the improvement in access to education, trade liberalization increases inequalities in countries with a share of no educated higher than 50%[34], or a share of highly skilled workers higher than 30%, the threshold value concerning the primary educated share remains constant through time.

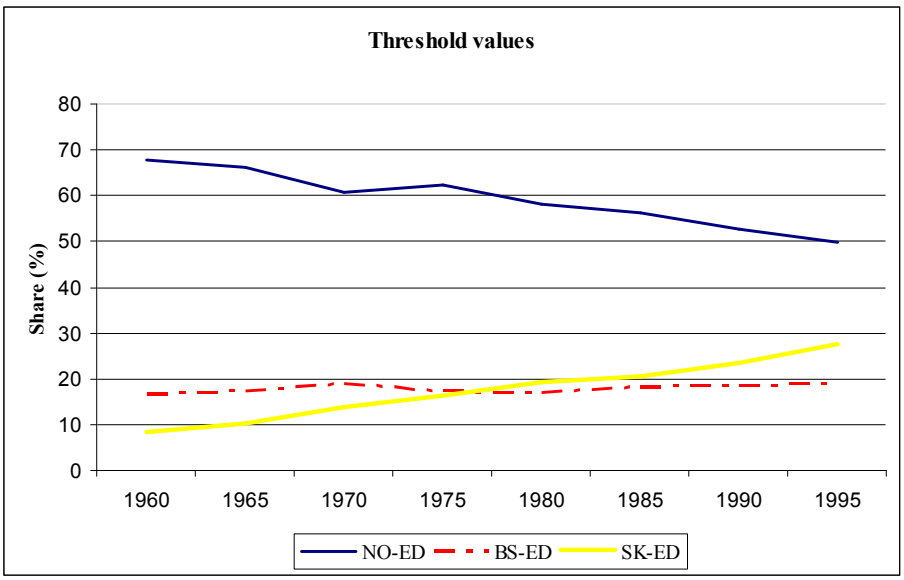



**Figure 1: Evolution of threshold values**

Using the specification in column 5, we now provide a quantification of an increase in endowment and an increase in openness. Table 7a shows us the percentile distribution of relative endowments in factors (a value of 1 implies that the endowment of the country is equal to world endowment, see annex 5a for full results).

[33] The impact of 20% share of no educated has not an equivalent impact concerning comparative advantage and specialization in the sixties and in the nineties.
[34] In Bendisoun and al. (2005) their threshold value concerning the share of no educated does not change through time, which is not convenient.

**Table 7a: Relative Factor Endowments: percentile distribution**

| Obs | Percentile | (K/L) | (AT/L | (MF/L) | (SK-ED/ BS-ED) | ((SK+BS)/ NO-ED) |
|---|---|---|---|---|---|---|
| 282 | 25 | 0.34 | 0.47 | 0.73 | 0.64 | 0.53 |
| | 50 | 0.94 | 0.90 | 0.85 | 0.92 | 1.15 |
| | 75 | 2.56 | 1.63 | 1.01 | 1.31 | 2.94 |

Table 7b computes results concerning a change in endowments for a country relatively well open (rank 6 on our index). The first column shows a change from the endowment of the 25th percentile to the median and the second column a change from the median to the 75th percentile. As expected an increase in capital from the 25th percentile endowment to the median endowment increases the Gini coefficient by 8.60% and an increase from the median endowment to the 75th percentile endowment increases inequality by 8.47%. We obtain a similar trend concerning skilled labor relatively to based educated labor increase inequality. Finally, having less non-educated labor decreases inequality (see annex 5b for full results).

**Table 7b: Factor endowment change and changes in Gini coefficient values (percentage changes)**

| | VAR 25-50 | VAR 50-75 |
|---|---|---|
| ((SK+BS)/NO-ED) | -6.56 | -8.78 |
| (SK-ED/BS-ED) | 1.49 | 1.46 |
| (MF/L) | 0.19 | 0.21 |
| (K/L) | 8.60 | 8.47 |

Notes: Percentages change in value of Gini coefficient

Table 7c quantifies the effects of a 50% **increase** in trade liberalization on Gini coefficient values for different quartiles of the distribution of endowments. As, an example, this trade liberalization

reduces the value of the Gini coefficient by 0.52% for countries in the bottom quartile of the distribution of (K/L), while it increases inequality by 0.77% for those in the top quartile. A similar pattern holds for (SK-ED)/(BS-ED), with the strongest effect for the ratio (SK+BS)/(NO-ED)). Since countries with a high share of non-educated population are also likely to be poorly endowed in capital, the two effects will tend to cancel each other (see annex 5b for full results).

**Table 7c: Trade Liberalization (50%) and Inequality**

| Variable | Percentile | Variation 50% |
|---|---|---|
| (K/L) | 0.25 | -0.518 |
| | 0.50 | 0.132 |
| | 0.75 | 0.775 |
| (SK-ED/BS-ED) | 0.25 | -0.203 |
| | 0.50 | 0.100 |
| | 0.75 | 0.398 |
| ((SK+BS)/NO-ED) | 0.25 | 0.546 |
| | 0.50 | 0.090 |
| | 0.75 | -0.465 |

### *4.4 Robustness checks*

The results are robust when we exclude a small number of observations signalled as outliers by a test on residuals[35]. We now summarize the results of several robustness checks (to save space, results are reported in annexes). In Annex 6 we estimate simultaneously the impact of trade openness according to endowment in non educated (NO-ED) and primary educated (BS-ED) in column 1 and in primary educated and highly educated (SK-ED) in column 2. Results are conforming to our predictions. In columns 3 and 4 we test different measures of natural resources in land, namely, cereal land (CerT/L), crop land (CroT/L) and

[35] The test on studendized residuals leads us to exclude 15 observations.

forest land (Fort/L). Interestingly, distinguishing between forest-land, crop-land and cereal-land results in increasing inequality during trade liberalization for crop-land countries and forest-land countries, as suggested by the so-called staple theory of development.

In annex 7, we check whether the results are robust to other inequality indices given that different inequality measures place greater weight on different sections of the distribution—for instance, the Gini gives more weight to the middle. Rather than choosing another index, we proceed in a more general way and estimate regression using the income share of each quintile of the population instead of the Gini index, to find where exactly the changes take place. The pattern of the results still holds in this smaller sample, however results are barely significant, this is due mainly to the loose of several observations.

Regarding macroeconomic and institutional variables, we used those in Lopez (2003) (table in annex 8). Results show that original results are robust when using these controls with all the macroeconomic variables having the expected sign (e.g. an improvement in civil liberties or an increase in government expenditure decreases inequality).

In a related paper, Gourdon, Maystre and de Melo (2006), have tested a similar specification, e.g. according to different factor endowments but on a shorter period (1980-2000). For the outcome variable we have used Gini coefficient as well as deciles but with another index of trade liberalization (tariffs). I find similar results concerning capital, natural resources (arable land, fuel & mining) and education level. This is comforting suggesting that our results are not influenced by index of trade liberalization. Also our results extend over a longer time period.

## 5 Conclusions

There are no clear cut empirical results on the relation between trade liberalization and income inequalities in developing countries. If one were asked to point towards an emerging consensus, the answer would be that the evidence on openness and overall inequality (usually measured by the Gini coefficient) remains very mixed: many studies find no evidence of openness on inequality, or that openness increases inequality at all levels of development. More intriguing is the lack of robustness towards expectations from the standard Hecksher-Ohlin-Samuelson (HOS) trade model: conflicting evidence that greater openness reduces (increases) inequality in developing (developed) countries. Much of previous research on the correlates of inequality has established that inequality is largely determined by factors that are quite different across countries and that change only slowly within countries. Notably, the effects of changes in trade policies and of globalization more generally, have been difficult to detect.

Accordingly, this paper has focused exclusively on within-country variations to changes in trade policy while carefully disaggregating factor endowments. Overall, the results suggest that changes in inequality are correlated with changes in trade policy which are quite robust to inclusion of various controls and to changes in sample periods. Notably, the study establishes the importance of factor endowment differences, which has eluded many previous estimates.

Using a data set covering a large sample of developing countries, we show that the conditional correlation between trade liberalization and inequality has the conventional effects suggested by HOS trade theory. These results which are derived from a model with improved controls for

omitted variables (countries heterogeneity and data sources) and a new index of openness are relatively robust. Using fixed effect country to control for countries heterogeneity allows us to study the relationship in change and not in level. The interesting issue from a policy perspective is not whether countries with different degrees of openness exhibit different levels of inequality, but rather whether an increase in a country's trade openness is associated with an increase or a decrease in inequality. Using a new index is motivated by the importance of taking in account the openness in imports as well as in exports. Trade liberalization increases inequality in countries that relatively well-endowed in capital. These results are to be contrasted with Spilimbergo et al. (1999) who find the inverse effect and attribute their finding that openness decreases inequality in countries relatively-well endowed in capital to a reduction in rents deriving from the ownership of capital.

First, as suggested by factor-proportions theories of international trade, increases in inequality are positively correlated with trade liberalization in countries well-endowed in highly skilled workers and with workers that have very low education levels but decreases inequality in countries that are well-endowed with primary-educated labor. Likewise, increases in inequality are positively correlated with trade liberalization in countries relatively well-endowed in mining and fuels production, assets which are very unequally distributed. Thus, if one extends the factor-proportions theory of trade to include a non-traded sector where those with minimal education are most likely to be employed, trade liberalization in poor countries where the share of the labor force with little education (workers that have not finished primary school) is high is likely to associated with increases in inequality as has often pointed out by critics of globalization. Trade liberalization is also associated with increases in inequality in capital-abundant and high-skill abundant countries so that

trade liberalization only reduces inequality in countries abundant in unskilled labor.

Second, the results on the pattern of signs are quite robust, and the addition of control variables yields plausible results. Controlling for the sources of income distribution data is always significant along expected lines. Finally, a reduction in macroeconomic instability (proxied by a reduction in inflation) also reduces within-country inequality.

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# APPENDICES

***A.1:*** *List of countries included in the sample 1970-2000*

| | Countries | Number of observations |
|---|---|---|
| Latin America | Argentina | 6 |
| | Bolivia | 3 |
| | Brazil | 6 |
| | Chile | 6 |
| | Colombia | 6 |
| | Costa Rica | 6 |
| | Dominican Rep. | 5 |
| | Ecuador | 3 |
| | El Salvador | 4 |
| | Guatemala | 4 |
| | Guyana | 2 |
| | Honduras | 3 |
| | Jamaica | 5 |
| | Mexico | 5 |
| | Nicaragua | 2 |
| | Paraguay | 2 |
| | Peru | 5 |
| | Trinidad & Tobago | 5 |
| | Uruguay | 3 |
| | Venezuela, RB | 6 |
| **Total** | **20** | **87** |
| Developed Countries | Australia | 5 |
| | Austria | 2 |
| | Canada | 6 |
| | Cyprus | 2 |
| | Denmark | 4 |
| | Finland | 5 |
| | France | 6 |
| | Greece | 5 |
| | Ireland | 5 |
| | Italy | 6 |
| | Japan | 6 |
| | Netherlands | 5 |
| | New Zealand | 5 |
| | Norway | 7 |
| | Portugal | 5 |
| | Spain | 6 |
| | Sweden | 5 |
| | Switzerland | 2 |
| | United Kingdom | 6 |
| | United States | 6 |
| **Total** | **20** | **99** |

| | Countries | Number of observations |
|---|---|---|
| Africa and Middle East | Algeria | 2 |
| | Botswana | 3 |
| | Cameroon | 2 |
| | Egypt, Arab Rep. | 2 |
| | Ghana | 3 |
| | Iran, Islamic Rep. | 4 |
| | Israel | 3 |
| | Jordan | 4 |
| | Kenya | 4 |
| | Lesotho | 3 |
| | Malawi | 4 |
| | Mauritius | 2 |
| | Senegal | 3 |
| | Sierra Leone | 2 |
| | South Africa | 6 |
| | Tunisia | 6 |
| | Uganda | 3 |
| | Zambia | 4 |
| | Zimbabwe | 2 |
| **Total** | **19** | **62** |
| Asia | Bangladesh | 5 |
| | China | 4 |
| | Fiji | 2 |
| | Hong Kong | 6 |
| | India | 5 |
| | Indonesia | 4 |
| | Korea, Rep. | 6 |
| | Malaysia | 5 |
| | Pakistan | 6 |
| | Philippines | 5 |
| | Singapore | 6 |
| | Sri Lanka | 6 |
| | Thailand | 6 |
| **Total** | **13** | **66** |

### *A.2:* *List of variables and data sources*

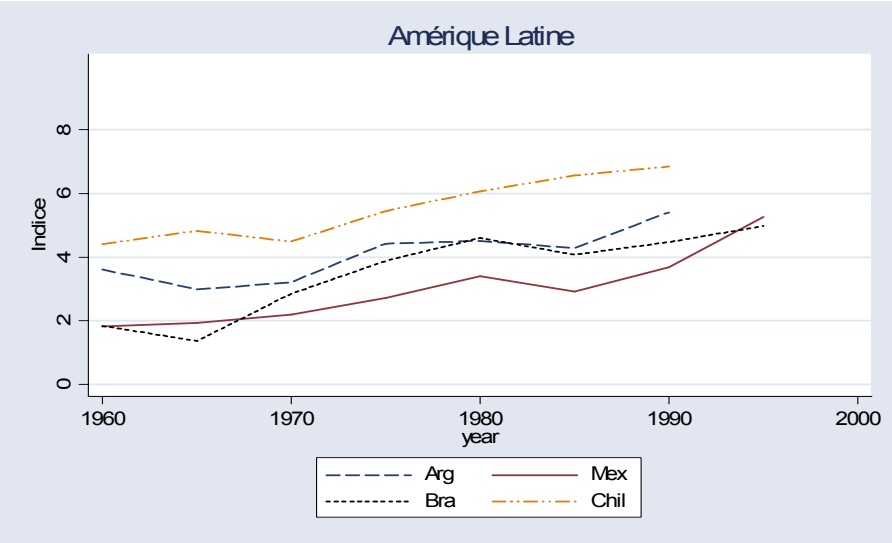
| Label | Content | Sources |
|---|---|---|
| Gini | Gini coefficients | WIDER(2004) |
| GDPpc | GDP per capita in power parity purchase (PPP) | Pen WorldTables (2005) |
| Capital | Capital per Worker | Easterly and Levine (1999) & Kraay and al. (2000) |
| Arable Land | Land arable per labor force (Cereal-land; Crop-land; Forest-land) | WDI (2004) |
| Mining & Fuel | Index Isham and al. (2005) base on net exports | Comtrade (2002) |
| Education | Average years of schooling in the population over 15 years old | Barro and Lee (2000) |
| No Educated | Proportion of the population over 15 years (non educated (or primary not completed) | Barro and Lee (2000) |
| Primary (Based) Educated | Proportion of the population over 15 years primary educated (completed) (or secondary not completed) | Barro and Lee (2000) |
| High (Skilled) Educated | Proportion of the population over 15 years High educated | Barro and Lee (2000) |
| Inflation | Annual growth rate of the GDP implicit deflator. The GDP implicit deflator is the ratio of GDP in current local currency to GDP in constant local currency. | WDI (2004) |
| M2/Gdp | Money and quasi money comprise as % of Gdp. | WDI (2004) |
| Gov Expenditure | Total expenditure includes both current and capital expenditures as % of Gdp | WDI (2004) |
| Civil Liberties | Measure the extent to which people are able to express their opinion openly without fears of reprisals and are protected in doing so by an independent judiciary. | Freedom House |
| Infrastructure | Quantity (Stock); Principal component analysis on road per km², telephone lines per workers, power Gigawatt per worker<br>Quality: waiting times for phone com., energy losses, paved road | Calderon and Serven (2004) |
| Tariffs | Import duties comprise all levies collected on goods at the point of entry into the country. In % of Imports | WDI (2004) |
| Index Dollar | Index of price distortion | Dollar (1992) |
| Index Pritchett | Adjusted Trade ratio: residual once we account for size and distance | Pritchett (1996) |
| Index Spilimbergo | Adjusted Trade ratio: residual once we account for size, distance and difference in factor endowment | Spilimbergo and al. (1999) |
| Index Leamer | Adjusted Net Trade ratio: residual once we account for size, distance and difference in factor endowment | Leamer (1987) |
| Index Hiscox & Kastner | Fixed country years effect in a gravity model once we account for size, distance and difference in factor endowment. | Hiscox & Kastner (2002) |
| Black market premium | Black market premium | WDI (2004) |
| Index Wacziarg & Welch | Index taking value 0 or 1 depending on liberalization | Wacziarg & Welch (2005) |
| Tax Barro & Lee | Tax on capital and input | Barro and Lee (2002) |
| (X+M)/Gdp | Output trade ratio | WDI (2004) |

### *A.3:* *Construction of index of relative factor endowment (RE)*

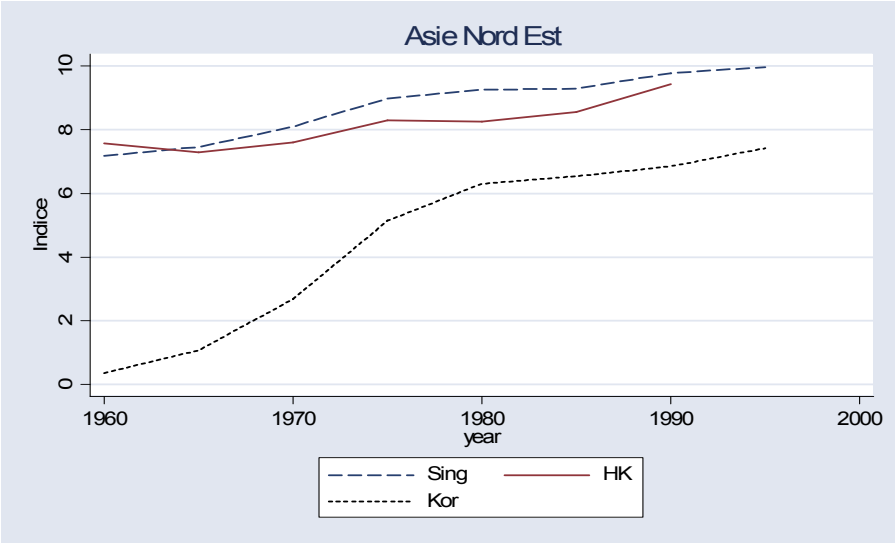
Let $E_{ift}$ is per capita endowment of country *i* in factor *f* in year *t* and $E^*_{ft}$ the world per capita effective endowment of country *i* in factor *f* in year *t* , computed by weighting every country's endowment by the population and by the degree of openness.

$$E^*_{ft} = \frac{\sum_i \left( E_{ift} \times pop_i \times \left( \frac{X+M}{GDP} \right)_i \right)}{\sum_i \left( pop_i \times \left( \frac{X+M}{GDP} \right)_i \right)}$$ The indicators of relative advantage is $RE_{ift} = \frac{E_{ift}}{E^*_{ft}}$

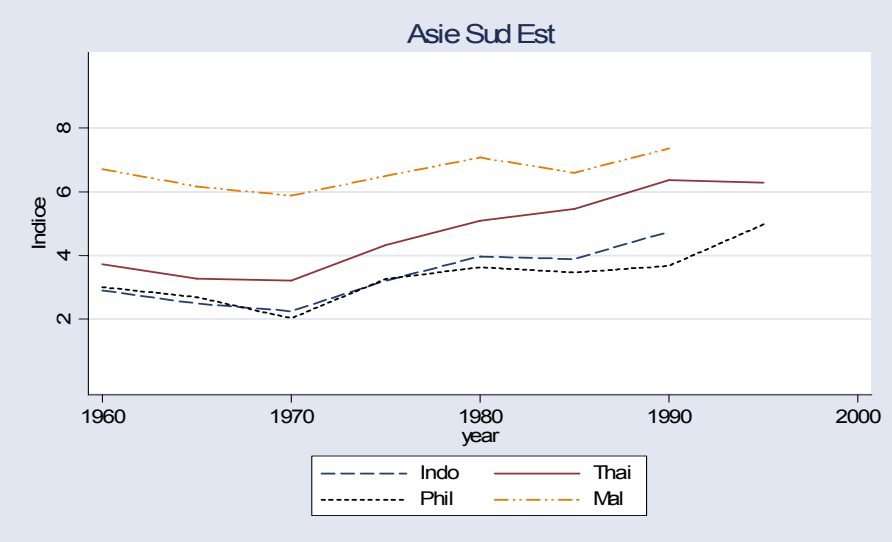
## *A.4:* *Index of Trade Openness*



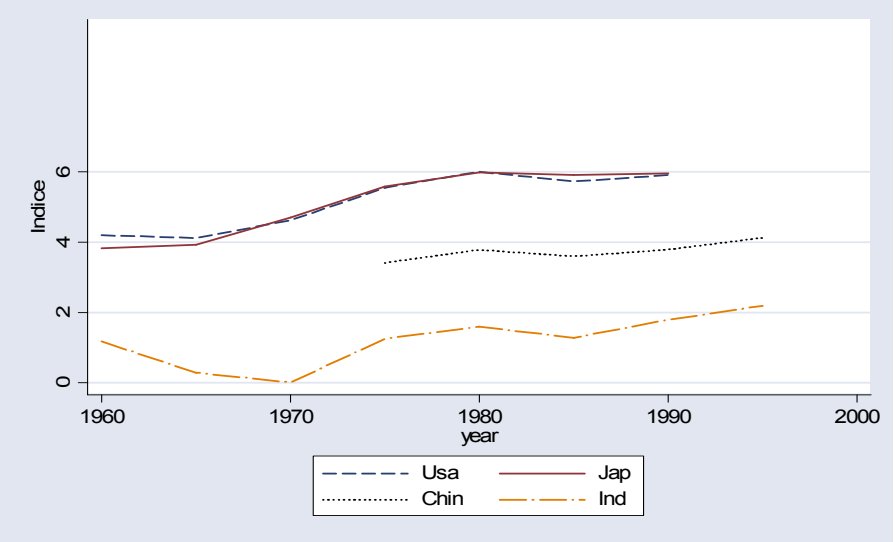

Graph 1: index for Latin American countries




Graph 2: Index for North East Asian countries




Graph 3: index for South East Asian countries




Graph 4: Index for other countries

***A.5a:*** *Relative Factor Endowments: percentile distribution*

| Obs | Percentile | (K/L) | (AT/L | (MF/L) | SK-ED/ BS-ED) | (SK+BS) /NO-ED | (NO-ED /L) | (BS-ED/ L) | (SK-ED/ L) |
|---|---|---|---|---|---|---|---|---|---|
| 282 | 25 | 0,34 | 0,47 | 0,73 | 0,64 | 0,53 | 0,52 | 0,71 | 0,41 |
| | 50 | 0,94 | 0,90 | 0,85 | 0,92 | 1,15 | 0,93 | 1,01 | 0,97 |
| | 75 | 2,56 | 1,63 | 1,01 | 1,31 | 2,94 | 1,29 | 1,39 | 1,83 |

***A.5b:*** *Tariff reduction, inequality and factor endowments (full result table 7b and 7c)*

| | VAR 25-50 | VAR 50-75 |
|---|---|---|
| ((SK+BS)/NO-ED) | -6.56 | -8.78 |
| (SK-ED/BS-ED) | 1.49 | 1.46 |
| (MF/L) | 0.19 | 0.21 |
| (K/L) | 8.60 | 8.47 |
| ((NO-ED)/L) | 4.61 | 2.16 |
| ((BS-ED)/L) | -2.94 | -2.56 |
| ((SK-ED)/L) | 8.39 | 5.44 |
| (AT/L | 0.17 | 0.15 |

| Variable | Percentile | Variation 50% |
|---|---|---|
| (K/L) | 0.25 | -0.518 |
| | 0.50 | 0.132 |
| | 0.75 | 0.775 |
| (AT/L | 0.25 | -0.321 |
| | 0.50 | 0.129 |
| | 0.75 | 0.358 |
| (MF/L) | 0.25 | -0.773 |
| | 0.50 | -0.344 |
| | 0.75 | 0.185 |
| (SK-ED/BS-ED) | 0.25 | -0.203 |
| | 0.50 | 0.100 |
| | 0.75 | 0.398 |
| ((SK+BS)/NO-ED) | 0.25 | 0.546 |
| | 0.50 | 0.090 |
| | 0.75 | -0.465 |
| ((NO-ED)/L) | 0.25 | -1.252 |
| | 0.50 | -0.437 |
| | 0.75 | 0.005 |
| ((BS-ED)/L) | 0.25 | -0.377 |
| | 0.50 | -0.665 |
| | 0.75 | -0.921 |
| ((SK-ED)/L) | 0.25 | -1.357 |
| | 0.50 | -0.728 |
| | 0.75 | -0.265 |

***A.6:*** *Different Measure for Human Capital and Land resources*

| | (1) | (2) | | (3) | (4) |
|---|---|---|---|---|---|
| | Ln Gini | Ln Gini | | Ln Gini | Ln Gini |
| Ln $(K/L)_{t-5}$ | -0.0358 | -0.0561 | Ln $(MF/L)_{t-5}$ | -0.3926a | -0.3820a |
| | (0.46) | (0.72) | | (3.46) | (3.18) |
| Ln $(AT/L)_{t-5}$ | -0.0056 | 0.0240 | Ln $(CerT/L)_{t-5}$ | 0.0637 | 0.0772 |
| | (0.16) | (0.67) | | (1.01) | (1.21) |
| | | | Ln $(CroT/L)_{t-5}$ | -0.0287 | -0.0324 |
| | | | | (0.60) | (0.72) |
| Ln $(NO\text{-}ED/L)_{t-5}$ | -0.1453 | | Ln $(ForT/L)_{t-5}$ | | 0.0893 |
| | (1.29) | | | | (1.51) |
| Ln $(BS\text{-}ED/L)_{t-5}$ | -0.0408 | 0.0511 | Ln $(SK+BS/NO\text{-}ED)_{t-5}$ | -0.0198 | 0.0079 |
| | (0.42) | (0.67) | | (0.53) | (0.21) |
| Ln $(SK\text{-}ED/L)_{t-5}$ | | -0.0361 | Ln $(SK\text{-}ED/BS\text{-}ED)_{t-5}$ | -0.0765c | -0.0806c |
| | | (1.07) | | (1.66) | (1.74) |
| $Openness_{t-5}$ | -0.0067 | -0.0131 | $Openness_{t-5}$ | 0.0048 | -0.0021 |
| | (0.65) | (1.25) | | (0.50) | (0.20) |
| Ln $(K/L)_{t-5}$*$Op_{t-5}$ | 0.0088c | 0.0097c | Ln $(MF/L)_{t-5}$*$Op_{t-5}$ | 0.0804a | 0.0807a |
| | (1.80) | (1.85) | | (2.83) | (2.67) |
| Ln $(AT/L)_{t-5}$*$Op_{t-5}$ | 0.0115 | -0.0012 | Ln $(CerT/L)_{t-5}$*$Op_{t-5}$ | 0.0036 | -0.0041 |
| | (1.64) | (0.15) | | (0.36) | (0.38) |
| | | | Ln $(CroT/L)_{t-5}$*$Op_{t-5}$ | 0.0138c | 0.0139c |
| | | | | (1.75) | (1.84) |
| Ln $(NO\text{-}ED/L)_{t-5}$*$Op_{t-5}$ | 0.0345c | | Ln $(ForT/L)_{t-5}$*$Op_{t-5}$ | | 0.0097 |
| | (1.71) | | | | (1.62) |
| Ln $(BS\text{-}ED/L)_{t-5}$*$Op_{t-5}$ | -0.0129 | -0.0136c | Ln $(SK+BS/NO\text{-}ED)_{t-5}$*$Op_{t-5}$ | -0.0008 | -0.0081 |
| | (1.31) | (1.70) | | (0.09) | (0.91) |
| Ln $(SK\text{-}ED/L)_{t-5}$*$Op_{t-5}$ | | 0.0169b | Ln $(SK\text{-}ED/BS\text{-}ED)_{t-5}$ *$Op_{t-5}$ | 0.0207c | 0.0212c |
| | | (1.96) | | (1.76) | (1.77) |
| Ln Inflation | 0.0020 | 0.0050 | Ln Inflation | -0.0034 | -0.0029 |
| | (0.20) | (0.50) | | (0.33) | (0.26) |
| gross/net income | 0.0040 | -0.0052 | gross/net income | 0.0067 | -0.0037 |
| | (0.22) | (0.28) | | (0.39) | (0.23) |
| income/expenditure | 0.0446a | 0.0529a | income/expenditure | 0.0375b | 0.0486a |
| | (3.15) | (3.80) | | (2.46) | (3.23) |
| Households/individual | 0.0854a | 0.0942a | Households/individual | 0.0878a | 0.0853a |
| | (3.18) | (3.60) | | (3.34) | (3.18) |
| Fixed effects | Yes | Yes | Fixed effects | Yes | Yes |
| Observations | 307 | 307 | Observations | 270 | 270 |
| Number of countries | 71 | 71 | Number of countries | 64 | 64 |

***A.7:*** *Inequality, different skill categories and openness: results by Quintile*

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | lnQuint1 | lnQuint2 | lnQuint3 | lnQuint4 | lnQuint5 | Gini |
| Ln $(AT/L)_{t-5}$ | -0.3706c | -0.1123 | 0.0249 | 0.0730 | 0.0082 | -0.0471 |
| | (1.91) | (0.97) | (0.35) | (1.45) | (0.15) | (0.59) |
| Ln $(MF/L)_{t-5}$ | 0.1428 | 0.0084 | 0.0775 | -0.0417 | -0.0100 | -0.1939 |
| | (0.42) | (0.04) | (0.54) | (0.52) | (0.09) | (1.62) |
| Ln $(K/L)_{t-5}$ | 0.2331 | -0.0575 | 0.0002 | -0.0261 | -0.0066 | 0.0421 |
| | (1.58) | (0.70) | (0.00) | (1.05) | (0.18) | (0.79) |
| Ln $(SK+BS/NO-ED)_{t-5}$ | 0.0522 | -0.0440 | -0.0254 | 0.0060 | 0.0046 | 0.0005 |
| | (0.57) | (0.63) | (0.60) | (0.19) | (0.14) | (0.01) |
| Ln $(SK-ED/BS-ED)_{t-5}$ | -0.1358 | 0.0611 | -0.0298 | -0.0219 | 0.0402 | -0.1679a |
| | (1.07) | (0.60) | (0.41) | (0.48) | (1.02) | (3.47) |
| Openness $_{t-5}$ | 0.0250 | 0.0095 | 0.0049 | -0.0172c | 0.0051 | -0.0010 |
| | (0.92) | (0.46) | (0.37) | (1.66) | (0.53) | (0.07) |
| Ln $(AT/L)_{t-5}$*$Op_{t-5}$ | 0.0320 | -0.0065 | 0.0053 | -0.0117c | 0.0030 | 0.0105 |
| | (1.07) | (0.38) | (0.58) | (1.77) | (0.38) | (0.98) |
| Ln $(MF/L)_{t-5}$*$Op_{t-5}$ | -0.0479 | -0.0115 | -0.0288 | 0.0026 | 0.0156 | 0.0366 |
| | (1.61) | (0.24) | (0.91) | (0.14) | (1.67) | (1.35) |
| Ln $(K/L)r_{t-5}$*$Op_{t-5}$ | -0.0597b | 0.0051 | -0.0138 | 0.0025 | 0.0072 | 0.0147 |
| | (2.10) | (0.29) | (1.64) | (0.51) | (1.04) | (1.44) |
| Ln $(SK+BS/NO-ED)_{t-5}$*$Op_{t-5}$ | -0.0174 | -0.0091 | 0.0170c | -0.0011 | 0.0035 | -0.0128 |
| | (0.77) | (0.53) | (1.74) | (0.16) | (0.46) | (1.19) |
| Ln $(SK-ED/BS-ED)_{t-5}$ *$Op_{t-5}$ | 0.0210 | -0.0009 | -0.0132 | 0.0124c | -0.0078 | 0.0401a |
| | (0.68) | (0.04) | (0.73) | (1.76) | (0.83) | (3.21) |
| Ln Inflation | -0.0318 | -0.0236 | 0.0279 | -0.0183 | 0.0088 | 0.0138 |
| | (1.06) | (0.71) | (0.85) | (1.17) | (0.57) | (1.26) |
| household/individual | 0.0095 | 0.0186 | 0.0518a | 0.0540a | -0.0341a | 0.0229 |
| | (0.23) | (0.83) | (2.77) | (4.54) | (2.66) | (1.32) |
| Income/expenditure | 0.1784 | -0.1248 | -0.1720b | -0.1377a | 0.0742 | 0.1251a |
| | (1.12) | (1.30) | (2.43) | (3.19) | (1.49) | (4.51) |
| Gross/net income | -0.1779 | -0.0013 | -0.0366 | -0.0057 | 0.0370 | 0.0088 |
| | (1.20) | (0.02) | (1.04) | (0.24) | (1.02) | (0.52) |
| Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 217 | 217 | 217 | 217 | 217 | 217 |
| Number of countries | 56 | 56 | 56 | 56 | 56 | 56 |

***A.8:*** *Adding macro and institutional variables as control*

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | Ln Gini | Ln Gini | Ln Gini | Ln Gini |
| Ln $(AT/L)_{t-5}$ | -0.0768 | -0.1231c | -0.2123a | -0.3029a |
| | (1.08) | (1.74) | (2.62) | (4.40) |
| Ln $(K/L)_{t-5}$ | 0.0195 | 0.0336 | 0.0347 | 0.0024 |
| | (0.51) | (0.82) | (0.72) | (0.05) |
| Ln $(SK+BS/NO-ED)_{t-5}$ | 0.0331 | 0.0114 | 0.0483 | -0.0575 |
| | (0.96) | (0.32) | (0.91) | (1.17) |
| Ln $(SK-ED/BS-ED)_{t-5}$ | -0.1212a | -0.1142a | -0.0921c | 0.0275 |
| | (2.98) | (2.65) | (1.69) | (0.42) |
| $Openness_{t-5}$ | 0.0067 | 0.0085 | 0.0154 | 0.0138 |
| | (0.63) | (0.76) | (1.07) | (1.03) |
| Ln $(AT/L)_{t-5}$*$Op_{t-5}$ | 0.0130c | 0.0194b | 0.0271a | 0.0381a |
| | (1.73) | (2.56) | (3.15) | (4.95) |
| Ln $(K/L)r_{t-5}$*$Op_{t-5}$ | 0.0079 | 0.0097 | 0.0135 | 0.0188c |
| | (1.09) | (1.26) | (1.41) | (1.93) |
| Ln $(SK+BS/NO-ED)_{t-5}$*$Op_{t-5}$ | -0.0149c | -0.0107 | -0.0204c | 0.0066 |
| | (1.83) | (1.22) | (1.66) | (0.56) |
| Ln $(SK-ED/BS-ED)_{t-5}$ *$Op_{t-5}$ | 0.0259b | 0.0251b | 0.0215 | -0.0137 |
| | (2.50) | (2.27) | (1.61) | (0.85) |
| Ln Inflation | -0.0062 | -0.0017 | 0.0038 | 0.0187 |
| | (0.64) | (0.17) | (0.34) | (1.55) |
| Ln Civil Liberties | 0.0553c | 0.0548 | 0.0751c | 0.0201 |
| | (1.66) | (1.55) | (1.94) | (0.52) |
| Ln Gov. Expenditures (%Gdp) | | -0.0515 | -0.0117 | -0.0046 |
| | | (1.45) | (0.32) | (0.14) |
| Infrastructure stock (index) | | | 0.0130 | 0.0137 |
| | | | (0.52) | (0.52) |
| Infrastructure quality (index) | | | -0.0135 | -0.0182b |
| | | | (1.57) | (2.31) |
| Ln Financial depth (M2/Gdp) | | | | 0.0308 |
| | | | | (1.02) |
| gross/net income | 0.0066 | 0.0152 | 0.0246 | -0.0147 |
| | (0.40) | (0.93) | (1.32) | (0.91) |
| income/expenditure | 0.0399a | 0.0300b | 0.0414a | 0.0248 |
| | (2.96) | (2.30) | (2.61) | (1.55) |
| Households/individual | 0.0676a | 0.0870a | 0.1346a | 0.1513a |
| | (2.72) | (3.58) | (4.75) | (6.30) |
| Fixed effects | Yes | Yes | Yes | Yes |
| Observations | 282 | 252 | 217 | 169 |
| Number of countries | 66 | 59 | 52 | 42 |

# CHAPTER 3: TRADE AND WAGE INEQUALITY IN DEVELOPING COUNTRIES: SOUTH-SOUTH TRADE MATTERS


***Abstract***

The relationship between trade liberalization and inequality has received considerable attention in recent years. The first purpose of this paper is to present new results on the sources of wage inequalities in manufacturing taking into account South-South (S-S) trade. Globalization not only leads to increasing North-South (N-S) trade, but the direction and composition of trade has also changed. More trade is carried out between developing countries. We observe that increasing wage inequality is associated more to the South-South trade liberalization than to the classical trade liberalization with northern countries. A part of this increasing wage inequality due to S-S trade comes from the development of N-S trade relationship in S-S trade which increases wage inequality in middle income developing countries. The second purpose is to elucidate the link between the direction of trade and technological change. We explore the fact that S-S trade leads more to a technological change biased toward skill intensive sector. This increases wage inequality for all developing countries. This indirect effect is more important in low income countries.



JEL classification: F1, J3, O3

Keywords: International Trade, Wage Inequality, Skill-biased technical change

## 1 Introduction

The relationship between trade liberalization and inequality has received considerable attention in recent years. Integration with world markets bears the promise of prosperity in developing countries. Concerning inequality the predictions by economists would be that lower tariffs and transportation costs should push each country to specialize in the production of the goods for which it has a comparative advantage. Since unskilled labor is the abundant factor in the developing world and skilled labor the abundant factor in the developed world, globalization should therefore be associated with an increase in the relative demand for unskilled labor in poor countries, thereby resulting in a reduction in wage inequality. However, empirical evidence does not support this expected result. Studies on income distribution do not find clear cut results and studies on wages find mainly an increasing wage inequality during trade liberalization (often in Latin American countries). Faced with this unexpected result several studies provide explanations concerning wage inequalities during trade liberalization (Goldberg and Pavnick 2004). The main explanation used is the skilled-biased technological change incorporated in trade liberalization which favors the wage of skilled workers in North and South countries.

In this paper, I propose another explanation: the direction of trade. A developing country might trade with another developing country. Hence the impact on wage inequality in this case may not correspond to the classical Stolper-Samuelson result. Then, taking into account South-South (S-S) trade, we come back to the effect of skill-biased technological change in considering a sector-biased technological change rather than a factor-biased technological change.

Pursuing this reasoning, globalization not only leads to increasing North-South (N-S) trade, but the direction and composition of trade has also changed. More trade is carried out between developing countries, and more developing countries are now exporting manufactures. Indeed South-South trade now accounts for around two fifths of all developing country merchandise trade and around 12 per cent of global merchandise trade. Trade liberalization has underpinned this development, with average tariff levels around one-third of their 1983 levels. As developing country markets become more important for other developing countries, and future trade liberalization will mainly concern South-South trade[36], we need to examine closely their trade policies and their impact on inequality[37].

First, in accounting for heterogeneity in the South we might discover that upper middle income countries are the "Northern" countries among developing countries and this South-South trade will increase wage inequality in those middle-income countries. In this case, effects are only a transposition of classical North-South trade theory.

Second, trade liberalization with Northern or Southern countries could also bring inequality among workers if those who have the skills needed to adjust to the new technologies benefited from increased economic integration while the others were left behind. Here the question is how to link trade liberalization, technological change and wage inequality. Several studies link them, using skill-biased technological change. However, Haskel and Slaughter (2002) showed recently that,

[36] It is notable that around 70 per cent of tariffs faced by developing countries are levied by other developing countries.

[37] Here we restrict globalization to trade liberalization, outsourcing, immigration and capital account openness, as they affect trade flows in goods. A measure which could do a distinction between trade liberalization with a northern partner and trade liberalization with a southern partner does not exist (the tariffs by partner's country are available on TRAINS since 1989). So we mainly use a ratio of trade flows on output.

concerning the USA and UK, it was the sector-biased technological change and not the skill-biased technological change which matters to explain wage inequality. Taking this perspective, we explore if S-S trade increases more TFP in skill-intensive sectors than in unskill-intensive sectors comparatively to N-S trade.

Concerning inequality we only focus on wage inequality which is closest to the predictions of Stolper-Samuelson. Most previous studies on wage inequality concerned only country case studies (mainly Latin American countries) because of the lack of comparable wage data across countries. However developing countries are heterogeneous and it is difficult to obtain global results from country case studies. Studies on panels of developing countries used Gini coefficients which measure inequality in income and so include the revenue from capital and natural resources. Recently we have had access to a homogeneous dataset on inter industry wage inequality. So here we deal with wage inequality across industries and not between workers as usual in the literature on wage inequality.

More precisely, the primary purpose of this paper is to present new results on the sources of wage inequalities in manufacturing taking into account South-South trade. We use two trade ratios, the first one measures trade liberalization with developed countries and the second one measures trade liberalization with developing countries[38]. In including them successively and together in an estimation of wage inequality, we observe increasing wage inequality is more due to the South-South trade liberalization than to the classical trade liberalization with northern countries. In clustering our sample of developing countries according to

[38] In addition we replicate this test in using two indexes of trade policy openness for developing countries obtained from a gravity model of bilateral trade data.

their income we can observe if this effect is more important in middle income countries since in S-S trade the comparative advantage of middle-income countries shifted to goods of intermediate skill intensity.

The second purpose is to elucidate the link between the direction of trade and technological change, arguing that it might explain why we obtain different results for South-South trade and North-South trade on wage inequality. Studies that link trade liberalization and technological change assume that increasing imports of machines have increased wage inequality in developing countries by introducing skill-biased technological change (SBTC). Effectively using these machines requires skilled workers and increases the relative demand for skilled workers**.** Moreover it could increase the productivity and the remuneration of those skilled workers. However, Haskel and Slaughter (2002) demonstrate that in many cases it is the sector bias of SBTC that determines SBTC' effect on relative factor prices, not its factor bias. Rising (falling) skill premia are caused by SBTC that is concentrated in skill-intensive (unskill-intensive) sectors. Hence we observe if in developing countries, S-S trade increases more TFP in skill-intensive sectors than in unskill-intensive sectors comparatively to N-S trade. This could explain why S-S trade increases wage inequality in all developing countries and not only in middle income countries.

To anticipate our results, we observe first that increasing share of S-S trade increases wage inequality for all developing countries. Second a part of this increasing wage inequality due to S-S trade comes from the development of N-S trade relationship in S-S trade which increases wage inequality in middle income developing countries. Third, the fact that S-S trade leads more to a technological change biased toward skill intensive sector increase wage inequality for all developing countries. Fourth, this indirect effect is more important in low income countries.

The remainder of the chapter is organized as follows. Section 2 presents a literature review on trade liberalization and wage inequality in developing countries. Section 3 presents our approach for this paper. Section 4 presents the descriptive statistics on all aspects of S-S trade and N-S trade in our database which concerns 68 developing countries for 1976-2000 for 27 manufacturing industries and which is based on Nicita and Olareagga (2006). Section 5 presents the results concerning our assumption on the impact of S-S trade and N-S trade on wage inequalities with an OLS estimator and some robustness check. Section 6 presents the results with a GMM system estimator. Section 7 concludes.

## 2 Review of the Empirical Literature

### *2.1 Basic Stopler-Samuelson Theory*

The crucial feature of the "standard" theory (i.e. factor endowment based theory) on the determinants of wage inequality is the correspondence between product prices and factor prices. This implies that an increase in the relative price of a good results in an increase in the relative return of the factor used intensively to produce that good. An extension to the above analysis considers capital, skilled and unskilled labour as the relevant factors of production. Hence if unskilled labor is the abundant factor in the South, the prediction of the theory is that the returns to unskilled labour should increase following trade liberalisation.

### *2.2 Evidence for Developing Countries*

The experience of the East Asian newly-industrialised economies was a reduction in wage inequality after openness was introduced in the 1960s and 1970s. This was therefore consistent with "standard" trade theory

which predicts that trade liberalisation should benefit the locally abundant factor (Wood, 1994, 1997). However, the generality of this optimistic outcome has been challenged by a number of studies for countries that opened up to trade more recently, mostly for Latin America (see summary of results in tables 1a and 1b).

Robbins (1996), for example, examines the changes in the structure of wages after trade liberalisation in Chile and finds that, although the content of skilled labour in imports exceeds the content in exports, the returns to skilled labour grew following liberalisation. Cragg and Epelbaum (1996) find that the increase in the returns to education in Mexico contributed to the rise of relative wages of skilled workers and that this effect is highest in traded sectors. Feenstra and Hanson (1997) show that the American 'maquiladoras' in the north of Mexico caused a significant increase in the relative demand for skilled workers in the border region with the US. Robbins and Gindling (1999) investigate the changes in relative wages and in the supply and demand for skilled labour in Costa Rica before and after trade liberalisation. They find that the skill premium rose after liberalisation as a result of changes in the structure of labour demand. Beyer and al. (1999) use a time series approach and find a long-term correlation between openness and wage inequality in Chile. Hanson and Harrison (1999) examine the changes in both wages and employment of skilled and unskilled workers after trade liberalisation in Mexico. They find little variation in employment levels, but a significant increase in skilled workers' relative wages. They also show that foreign companies and those heavily involved in export markets pay higher wages to skilled labour. Finally, for Brazil, Green and al. (2001) find an increase in the returns to college education following trade liberalisation. However, contrary to studies for other developing countries, there was no apparent change in overall wage inequality. Recently, Galiani and Sanguinetti (2003) find that

import penetration explains a small part of wage premium in Argentina and Milanovic and Squire (2005) find that decreasing tariffs increase inequality both in inter industry wages and inter occupation wages in developing countries.

Thus, the evidence on trade liberalisations which have been implemented in the last two decades (mainly, but not exclusively, for Latin America), suggests a positive relationship between trade liberalisation and wage inequality. This finding is clearly contrary to the predictions of the traditional theory of international trade.

### *2.3 Heterogeneity among developing countries*

First authors have accounted for heterogeneity among developing countries in human capital, arguing that some developing countries did not present a comparative advantage in unskilled labor. Thus, to explain the difference of liberalization in wage inequality between Latin American and Asian countries, Wood (1997) suggests that the timing of trade policy reform is important by making this point: when Latin American countries liberalized, they were no longer unskilled labor abundant, because India and China had already accessed international markets. Thus contrary to East Asian countries which liberalized earlier, at a time when they were unskilled labor abundant, Latin American countries were not relatively abundant in unskilled labor.

In the same vein, Davis (1996) presents a model in which the central hypothesis is that the availability of a country's factors of production should be assessed in relation to a group of countries with similar endowments, rather than in relation to the wider international economy. Thus, the availability of factors should be considered from a relative, and

not from an absolute, perspective. What matters in the model is the relative position of the country amongst other countries within its own cone of diversification. Each cone comprises countries with similar, though not identical, factor endowments. This gives each country a different comparative advantage inside its cone, leading to a specialisation of production. In this framework, trade liberalisation can raise the demand for skilled labour in a developing country as long as among the countries of its cone, it has a relatively high supply of skilled labor.

Several studies on wage in Latin America (Harrison and Hanson 1999) find that unskilled-labor intensive sectors were protected with the highest tariffs prior to trade reform. So those industries experienced the largest tariff reductions during trade reform. This puzzling fact shows that "the increase in the skill premium" is exactly what Stopler-Samuelson predicts: since trade liberalization was concentrated in unskilled-labor intensive sectors, and so the economy-wide return to unskilled labor should decrease.

### *2.4 Shifting industries from North to South*

Second, trade liberalization benefits the unskilled-labor intensive industry in developing countries but leads also to the shift of industry activities intensive in unskilled labour from North to the South which could increase inequalities (notably through FDI). Two effects could increase relatively demand for skilled labor in developing countries during trade liberalization: the industry effect and the occupation effect.

The industry effect deals with the shift of skill-intensive intermediate goods production from developed to developing countries. The idea is that the flow of FDI changes the structure of production and increases the stock of capital of developing countries. Feenstra and Hanson

(1996) develop a model which assumes the production of a simple final good that requires a *continuum* of intermediate goods with varying proportions of skilled and unskilled labor. The model suggests that the stages of production which demand less skilled labour (by the measure of the advanced country) will be transferred to the less developed countries where unskilled labor is relatively cheaper. However, the kind of labor that is actually demanded is skilled when judged from the perspective of the developing countries.

The occupation effect deals with the fact that the rapid pace of change in the economy increased the demand for individuals that could enact change: managers and professionals, whatever the industry. Cragg and Epelbaum's work (1996) on Mexico reports that the occupation effect seems more relevant than the industry effect to explain wage inequality.

### *2.5 Skill-biased technological change*

Thirdly, the main alternative explanation to demand shifts is the inclusion of technological change which complicates seriously the prediction. The inclusion of differences in technology in the wage literature deals with biased technological change. An additional effect of trade liberalisation is a rapid inflow of foreign technology as a result of both FDI and increased imports. As different recent models show, a skill-biased technological change can be indirectly and partly induced by trade policy [see for example, Thoenig & Verdier (2003), Acemoglu (2003) or Aghion et al. (2003)].

A large part of the literature argues that trade liberalization can increase wage inequalities via the import of machines. Authors argue that those imports increase the demand for skilled labor to use with these machines and improve the productivity of skilled worker as it includes a

skill-biased technical change (Harrison Hanson 1999, Gindling Robbins 2001, Attanasio and al. 2004).

Harrison and Hanson (1999) find that the trade reform did play a part but that other factors including foreign direct investment, export orientation, and technological change were also important. Beyer, Rojas and Vergara (1999) find a similar effect of trade reform on wage-inequality in Chile because skill-intensive, resource based industries expanded following liberalization. Arbache, Dickerson and Green (2001) find that following the extensive trade liberalization in Brazil in the 1990s, average wage in the traded sector fell compared to the non-traded sector (even after adjusting for education, experience etc.), and that the only category that was spared a decline were the highly educated because the returns to education went up. They argue that these results are consistent with the erosion of rents in the traded sector in the wake of opening up, and complementarity between new technologies brought in by globalization and skilled labor.

### *2.6 Industry wage premiums*

Fourth, while most work has focused on potential explanations for the increasing inequality between skilled and unskilled workers, the skill premium alone cannot fully explain the increase in inequality in developing countries. Several studies consider industry wage premiums as an alternative channel through which trade liberalization may have contributed to wage inequality. Industry wage premiums refer to the part of worker wages that cannot be explained by observable worker characteristics such as gender, age, education, experience, etc., but can be attributed to workers' industry affiliation.

Trade-liberalization induced changes in industry wage premiums could contribute to increases in the wage inequality between skilled and

unskilled workers. If trade liberalization leads to declines in industry wage premiums, wage inequality between skilled and unskilled workers could increase if the industries with the largest tariff cuts are the ones employing a higher share of unskilled workers and if these industries had the lowest wage premiums prior to the reform.

Here evidence on how responsive industry wage premiums are to trade reforms is mixed. Some studies find no association between tariffs and industry wage premiums (Feliciano (2001) for Mexico, Pavcnik, Blom, Goldberg, and Schady (2004) for Brazil), while others find a positive association between tariff declines and industry wage premiums (Goldberg and Pavcnik (2004) for Colombia). Feliciano (2001) reports a positive association between declines in import licenses and industry wage premiums. Thus, in Colombia and Mexico, trade liberalization might have lead to increased wage inequality through the industry wage premium channel, especially since tariff cuts in these countries were the largest in unskilled-labor intensive industries and the sectors with the largest tariff cuts had the lowest wage premiums prior to the reform (Attanasio, Goldberg and Pavcnik (2004)).

### *2.7 Cross-countries studies*

Notwithstanding the studies reviewed above, there remain important questions as to how far the conjecture that trade liberalisation may enhance skill demands can be generalised to all developing countries. Reconciling these results is difficult because they cover different countries and time periods (and could therefore be reflecting different relationships) and because they use different specifications and variable definitions. What is perhaps more disconcerting is the fact that the design of the surveys from developing countries often changes from year to year, making comparisons

across years difficult. One conclusion that emerges is that we should use cross-countries studies in order to use an homogeneous dataset and to allow country categorization between low and middle income countries which might be very important.

Recent studies use a cross-countries dataset (table 1b). Zhu and Trefler (2005) showed that the technological catch up that they measure with labor productivity (without linking it to imports), does not increase directly wage inequality but allows developing countries to be specialized in more skill intensive products in their exports and hence to increase wage inequalities indirectly[39].

All the cross-country studies use, the dataset from Freeman and Ostendorp (2001) which provides wage for different occupations in each industry and allows to measure wage inequality among workers in each industry. The coverage in all its dimensions, however, is problematic and fragmentary. Although there are 156 countries in total on 1983-1999, each country does not provide data (occupational wages) for every year. The yearly country coverage varies between 48 and 76. Occupations included also vary from country to country. Moreover for a given country even when it does provide the annual data, the occupational coverage is not necessarily uniform for each year. Using properly this dataset implies to seriously reduce the sample and exclude several low-income countries.

[39] A variation on this theme is the conjecture that, even if the technology to be transferred is neutral, the transitional process of transferring and installing new technologies may be skill-biased (Pissarides, 1997). In this case, the effect on the returns to human capital will be temporary and skilled workers benefit only during the transition period to the new, higher, technological level. Goldin and Katz (1998) reach a similar conclusion. They argue that the demand for skilled workers can follow a technological cycle. The demand rises when new technologies and machinery are introduced, but it declines once the other workers have learned to use the new equipment.

The recent study from Milanovic and Squire (2005) use also an inter-industry wage dispersion dataset. This approach allows using a larger sample since those data are easier to collect. However the implications are different since in doing this the wage inequalities are sector-based whereas they are skill-based in the other studies.

It is also of interest to examine the extent to which trade liberalisation is correlated to an increasing wage inequality, regarding the fact that South-South trade now accounts for around two fifths of all developing country merchandise trade. To address these issues, the following section presents some new evidence regarding the impact of trade liberalisation in a case of South-South trade relative to North-South trade.

**Table 1a: Summary of recent country studies**

| **Studies** | Measure for wage inequality | Measure for trade openness | Alternative explanations | Main results |
|---|---|---|---|---|
| **Feenstra & Hanson 1997** Mexico 1975-1988 | Relative non production wage share | | FDI by number of Maquiladoras | FDI increase non producer wages share so FDI increase wage inequality |
| **Cragg & Epelbaum 1996** Mexico 1987-1993 | Industries dummies and occupation dummies in wage equation | Comparison of traded sectors with non traded sectors | | Occupation explains close to half of the wage inequality. Economy became more skill-intensive and that this effect was larger for the traded sector. |
| **Robins 1996** 9 developing countries 1974-1989 | Wage skilled worker / wage unskilled worker | Just analysis by period | Financial openness and Technical Change by machinery imports | Trade liberalization sometimes rise wage inequality, both financial openness and skill biased technical change increase inequality. |
| **Beyer, Rojas &Vergara 1999** Chile 1960-1996 | Difference in return to education on wages | Trade Liberalization by Trade to GDP | | Trade Liberalization has increased inequality. |
| **Harrison & Hanson 1999** Mexico | Wage skilled worker / wage unskilled worker | Trade Liberalization by Industry | Technology change by machinery | Wage inequality rise after trade Liberalization, FDI and Technological change |

| | | | | |
|---|---|---|---|---|
| 1984-1990 | | Tariffs rate | imports, license Financial openness by FDI | increase this effect. |
| **Gindling & Robbins 2001** Chile, Costa Rica 1974-1995 | Standard Deviation of log wages wage 90$^{th}$ decile / wage 10$^{th}$ decile | Trade Liberalization by Average Tariff rate | Skilled biased technology change by machinery imports | Trade Liberalization and Technological change explains difference in inequality between 2 countries. |
| **Green, Dickerson & Arbache 2001** Brazil 1981-1999 | Mean log deviation of wages Return to education | Just analysis by period | | Increase in education returns but no effect on wage inequality, no effect of trade liberalization. |
| **Galiani & Sanguinetti 2003** Argentina 1993-1997 | Difference in return to education on wages | Trade Liberalization by M to VA and X to VA in each industry | | Import penetration explain wage premium but just a small part only. |
| **Pavcnik 2003** Chile 1976-1986 | Wage skilled worker / wage unskilled worker | | Capital deepening Technology import | Capital deepening increases wage premium but adoption of foreign technology has no effect. |
| **Esquivel 2003** Mexico 1988-1994 1994-2000 | wage non production worker / wage production worker | Trade Liberalization by product prices | Technological Progress by labor productivity | Technological change increases wage inequalities and trade liberalization decrease wages inequalities in the first period. |
| **Attanasio, Goldberg& Pavcnik 2004** Colombia 1984-1998 | Std Deviation log wages wage 90$^{th}$ decile / wage 10$^{th}$ decile Industry dummies in wage equation | Trade Liberalization by M and X in each industry And Industry Tariffs | Skilled biased technology change by proportion of skilled workers | Trade Liberalization increase inequality through technology, and through growing informal sector (pay less). |
| **Goldberg& Pavcnik 2005** Columbia 1984-1998 | Industry dummies in wage equation | Trade Liberalization by Industry Tariffs | | Tariff cuts decrease unskilled wages since the most protected workers were unskilled. |
| **Mishra & Kumar 2005** India 1983-2000 | Industry dummies in wage equation | Trade Liberalization by Industry Tariffs | | Tariffs reduction increase wage, since tariff reduction is highest in unskilled worker intensive industry so Trade Liberalization reduce wage inequality. |

**Table 1b: Summary of recent cross-countries studies**

| Studies | Measure for wage inequality | Measure for trade openness | Alternative explanations | Main results |
|---|---|---|---|---|
| **Freeman & Ostendorp 2001** 83 countries 1983-1998 | wage 90$^{th}$ decile / wage 10$^{th}$ decile | Trade Liberalization by Trade to GDP | | Weak positive results |
| **Rama 2003** 103 countries 1983-1998 | Standard Deviation of log wages Return to education | Trade Liberalization by Trade to GDP and Sachs Warner index | Financial openness by FDI | No significant effect |
| **Zhu & Trefler 2005** 20 developing countries 1985-1998 in 4 periods | wage non production worker / wage production worker | Trade Liberalization by the amount of exports | Technological catch up by the change in skill composition of exports | Trade Liberalization has no effect, technological catch up explains wage inequality only by changing composition exports |
| **Milanovic & Squire 2005** 118 countries 1983-1999 90 countries 1975-1999 | Inter industry wage dispersion from UTIP Inter occupational wage dispersion from OWW | Trade Liberalization by global Tariffs | | Trade Liberalization increases wage inequality in developing countries |

## 3 South-South trade and wage inequality: a model

We explore two extensions relative to the existence of "South-South" trade and wage inequality in developing countries.

First, similarly to Wood (1997), we argue that South-South trade might explain increasing wage inequality in middle-income countries as they do not present a comparative advantage in unskilled labor intensive sectors in this South-South trade. Moreover, we also expect that increasing the share of South-South trade relatively to North-South trade could in crease wage inequality in low income countries, since imports should be less intensive in high skill-labor and exports more intensive in low skill-labor. It appears that we have to use a cross-countries dataset in order to categorize

countries according to their income. We choose to use an inter-industry wage dispersion dataset, as in Milanovic and Squire (2005), so we deal her with sector-based wage inequalities. We are comfortable with this approach since, in clustering industries by their intensity in skill-labor, we will observe which ones have an increasing wage relatively to the other sectors. We expect that in middle income countries wage in high skill-labor industries increase more rapidly that wages in low skill-labor industries.

This argument is also related to the wage industry premium explanation mentioned earlier and used in several studies on Latin American countries to explain wage inequality (Goldberg and Pavcnik (2005). If N-S trade leads to tariff cut and increasing importation in the high skill-labor industries and that S-S trade will lead mainly to tariff and increasing importation in the low skill-labor industries this could explain why S-S trade could increase more inter industry wage inequality than N-S trade.

Second, we explore if S-S trade and N-S trade have different impacts concerning sector-biased technological change. If S-S trade leads more to increasing competition in skill-intensive goods than N-S trade, it might bring technological change more biased towards skill-intensive sectors than N-S trade. Here again, using an inter-industry wage dispersion dataset is suitable regarding to our approach since we only focus on wages in each industry.

Leamer (1998) has made the argument in several papers that it is sector-bias, and not factor bias that is relevant for the income distribution. Skilled-biased technological change that is concentrated in unskilled-intensive sectors would benefit unskilled workers in the general equilibrium, while skilled-biased technological change concentrated in

skilled-intensive industries would benefit skilled workers. However, Leamer's argument rests on the assumption of fixed product prices, which is unlikely to hold during trade liberalization.

Recently, Haskel and Slaughter (2002) have considered the 'sector bias' of technological change. They present a model where it is the sector bias of technological change rather than the factor bias that determines the effect on relative wages, even in case of flexible prices (contrary to Leamer who assumed fixed prices). Technical progress in a sector will potentially raise profitability. If technical change occurs in the skill-intensive sector, then skilled wages must rise so that relative profitability falls back to its original level. If it occurs in the unskilled-intensive sector, then unskilled wages must rise. Note that all technical change matters (not only SBTC) since any advances might raise sector profitability. They test their model on UK and USA and find that decreasing wage inequality in 70's was due to SBTC in unskilled-intensive sectors and increasing wage inequality in 80's was due to SBTC in skilled-intensive sectors.

This suggests that researchers should look at skilled, unskilled and neutral technical change to see if there is an impact on wages. The impact of sector bias can be summarized: if prices or TFP grow faster in the skilled-intensive sectors, then skilled wages tend to rise relative to unskilled wages. But if prices or TFP grow faster in the unskilled-intensive sectors, then skilled wages tend to fall relative to unskilled wages. Thus, the appropriate empirical strategy is to examine whether price or TFP change is more concentrated in the skill- or unskilled-intensive sectors. This approach contrasts with studies that seek to document whether price or technical changes are occurring within sectors but not to compare across sectors.
In our framework of S-S trade and N-S trade we could attempt for a difference in sector biased according to the direction of trade.

On the export side, trade openness potentially increases innovation, knowledge and productivity by encouraging firms to find new ways to compete. Since for a developing country, N-S trade leads to export unskilled labor intensive goods, this would lead the country to improve its labor productivity in this unskilled–intensive sector to be competitive relative to other developing countries on the northern market. On the contrary, in case of S-S trade where countries trade relatively more in skilled-intensive products this would lead to increasing competition and labor productivity in those more skilled intensive industries.

## 4 South-South trade and wage inequality: A first look at the data

The exploration takes place with the data in relating to the econometric analysis of section 4. We use the database recently updated by Nicita and Olarreaga (2006). The database includes information on bilateral trade flows, production, labor, added value and wages in 101 countries over the period 1976 to 2004. The industry classification is the 3-digit level ISIC revision 2, which covers 28 manufacturing sectors.

Table 2 presents for three groups of developing countries (see Annex 1 for classification) the change between 1980 and 2000 in the direction of trade measured by total exports and total imports of manufactured products. We observe the expansion of South-South trade for all developing countries (roughly from 19-18% of exports and 9-12% of imports in 1980 to 35-50% of exports and 30-40% of imports in 2000). It seems that developing countries have really benefited from this expanded South-South trade, and it concerns mainly the middle income countries which multiplied their share of S-S trade by five.

**Table 2: Expanding South-South trade by developing countries clusters**

| *Export* | | | | | *Import* | | | |
|---|---|---|---|---|---|---|---|---|
| **North** | **Mid. Up** | **Middle** | **Low** | ***1980*** | **Low** | **Middle** | **Mid. Up** | **North** |
| 82.2 | 6.6 | 4.2 | 7.0 | **Middle Up** | 2.2 | 5.5 | 3.8 | 88.5 |
| 81.0 | 7.6 | 8.4 | 2.9 | **Middle** | 0.8 | 5.3 | 3.0 | 90.9 |
| 81.3 | 1.7 | 2.8 | 14.2 | **Low** | 4.0 | 4.2 | 1.5 | 90.2 |
| **North** | **Mid. Up** | **Middle** | **Low** | ***2000*** | **Low** | **Middle** | **Mid. Up** | **North** |
| 64.4 | 12.0 | 20.0 | 3.6 | **Middle Up** | 1.3 | 17.8 | 10.9 | 70.0 |
| 58.6 | 9.1 | 26.3 | 6.0 | **Middle** | 2.5 | 23.0 | 7.5 | 67.0 |
| 50.0 | 3.2 | 26.7 | 20.1 | **Low** | 4.8 | 30.8 | 5.3 | 59.1 |

### *4.1 Inter industry Specialization among developing countries*

*North-South relation in South-South trade*

Table 3 presents the share of exports and imports according to three clusters of products classified by skill labor intensity (see Annex 2 for classification from UNCTAD). We see that in 2000 the richest developing countries appear to export relatively more skilled intensive goods "HSL" (54% of total exports) and export fewer unskilled intensive goods "LSL" (30%) than low income countries (respectively 22% and 57%). This evidence seems to be consistent with the notion of a ladder of comparative advantage as defined by relative factor endowments.

**Table 3: Trade and Labor force by commodities clusters**

| | | *1980* | | | *2000* | | |
|---|---|---|---|---|---|---|---|
| | Goods | **Export** | **Import** | **Labor force** | **Export** | **Import** | **Labor force** |
| Middle Up | LSL | 38.1 | 24.5 | 51.8 | 29.6 | 19.1 | 52.2 |
| | MSL | 18.6 | 21.8 | 29.3 | 16.6 | 18.3 | 26.6 |
| | HSL | 43.3 | 53.7 | 21.3 | 53.8 | 62.6 | 23.0 |
| Middle | LSL | 50.1 | 21.6 | 53.4 | 38.3 | 22.5 | 48.7 |
| | MSL | 15.9 | 21.7 | 29.3 | 21.2 | 21.8 | 27.7 |
| | HSL | 34.0 | 56.7 | 18.7 | 40.5 | 55.7 | 25.4 |
| Low | LSL | 68.9 | 28.4 | 60.0 | 57.2 | 23.3 | 56.5 |
| | MSL | 17.2 | 19.3 | 26.7 | 20.4 | 25.7 | 29.2 |
| | HSL | 13.9 | 52.3 | 14.3 | 22.4 | 51.0 | 17.8 |

Therefore, as Wood (1997) suggested, this helps explain increasing wage inequality in middle income countries since the opening of the low income half of the world is likely to have altered the comparative advantage of middle-income countries in unskilled-intensive sectors. This pattern has been reported for Columbia (Attanasio, Goldberg and Pavcnik (2004), Mexico (Hanson and Harrison (1999), Robertson (2000)) and Brazil (Pavcnik, Blom, Goldberg and Schady (2004)).

*Industry wage premium*

Table 3 reveals that the distribution among sectors does not change a lot across countries and time, although middle-up income countries have less labor force in unskilled intensive sectors (52%) compared to low income countries (57%). And this lack of labor reallocation does not conform to traditional HO expectations where labor should reallocate from sectors with declining share to sectors with increasing share. This suggests that the adjustment of the labor market to trade liberalization occurred through relative wage adjustments and not through labor reallocation across sectors, thereby having an effect on the wage premium. In sum, if trade liberalization leads to declines in industry wage premiums, wage inequality between industries could increase if the industries with the largest tariff cuts are the ones employing a higher share of unskilled workers and if these industries had the lowest wage premiums prior to the reform.

Havrylyshyn (1985) finds that factor content characteristics are relevant in the trade of developing countries but observes that these characteristics vary according to the direction of trade. He finds that developing countries export more skilled and capital intensive products to the South than to the North while they import more skilled and capital intensive products from the North than from the South.

Table 4 details the shares of each product cluster: high skill labor intensive (HSL), medium skill labor intensive (MSL) and low skill labor intensive (LSL), in the bilateral trade flow between groups of countries. As Havrylyshyn (1985), we observe that exports from Southern countries to other Southern countries are more intensive in high-skilled labor (HSL) than exports to Northern countries (44,8% versus 38,2%) and less intensive in unskilled labor (33,5% versus 44,9%). At the same time, imports from Southern countries are more intensive in unskilled labor than from Northern countries (26, 4% versus 18,4%) and less intensive in skilled labor (46,2% versus 62,9%). The results hold when we decompose developing countries in three groups. Broadly speaking these ratios suggest that if South-South trade exports relatively less unskilled intensive products and imports relatively more unskilled intensive products, this may lead to increasing inequality relatively to North-South trade.

**Table 4: factor content in South-South trade and in North-South trade**

| 2000 | | Exports | | | | | Imports | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | North | South | Middle Up | Middle | Low | North | South | Middle Up | Middle | Low |
| **South** | LSL | 44.9 | 33.5 | | | | 18.4 | 26.4 | | | |
| | MSL | 16.9 | 21.6 | | | | 18.7 | 27.4 | | | |
| | HSL | 38.2 | 44.8 | | | | 62.9 | 46.2 | | | |
| Middle Up | LSL | 35.9 | | 23.2 | 28.2 | 34.2 | 15.3 | | 25.2 | 23.5 | 52.0 |
| | MSL | 15.3 | | 20.2 | 18.2 | 19.2 | 16.1 | | 25.0 | 22.2 | 14.8 |
| | HSL | 48.9 | | 56.6 | 53.6 | 46.6 | 68.6 | | 49.8 | 54.3 | 33.3 |
| Middle | LSL | 39.9 | | 37.6 | 30.5 | 19.9 | 20.4 | | 22.3 | 26.2 | 45.3 |
| | MSL | 18.9 | | 22.5 | 22.9 | 26.0 | 18.4 | | 28.5 | 31.3 | 16.7 |
| | HSL | 41.3 | | 39.9 | 46.6 | 54.2 | 61.2 | | 49.2 | 42.5 | 38.0 |
| Low | LSL | 69.0 | | 56.8 | 53.1 | 43.5 | 19.1 | | 33.7 | 28.5 | 38.8 |
| | MSL | 15.7 | | 20.8 | 20.2 | 19.1 | 23.5 | | 23.0 | 29.1 | 24.0 |
| | HSL | 15.2 | | 22.4 | 26.6 | 37.3 | 57.4 | | 43.4 | 42.4 | 37.2 |

So we observe the existence of a N-S trade relationship among S-S trade due to heterogeneity between developing countries. This is consistent

with increasing inter-industry wage inequality in middle income countries. However we observe also that S-S trade implies more imports of unskilled intensive products and fewer exports of unskilled intensive products than N-S trade for all sorts of developing countries (even low income). This could lead to increasing wage inequality for all developing countries and not only in middle income countries.

### *4.2 Sector biased technological change*

To the extent that technological change is an endogenous response to intensified competition from abroad (see Acemoglu, 2003), one could argue that S-S trade was indirectly responsible for the increase in inter industry wage inequality[40].

Table 5 shows the correlation between shares by different partners, in export and in import, with TFP in three different clusters of industry for developing countries. TFP is computed as $TFP = \log Y - \alpha \log L - (1-a) \log K$, with an equal to labor's share. The capital stocks are derived from investment series using the perpetual inventory model with a 9% depreciation rate. The labor share is equal to the wage bill divided by the value of output. The coefficients are generally very low, however it seems that when the share of Northern partner in export and in import is highest the TFP in unskilled intensive sectors is also the highest, while when the share of middle income country is high (in exports or in imports) the TFP in unskilled intensive sectors is low. Moreover exports to low income country are positively correlated with high TFP in skilled intensive sectors.

[40] This argument is also related to Wood (1995) and to the more recent paper by Thoenig and Verdier (2003). See also the survey by Acemoglu (2003).

**Table 5: Direction of trade and TFP in sectors: correlation**

| | Partners | TFP LSL | TFP MSL | TFP HSL |
|---|---|---|---|---|
| Exports | **North** | **0.143** | -0.040 | -0.055 |
| | **Middle Up** | -0.075 | 0.052 | -0.005 |
| | **Middle** | **-0.224** | -0.071 | -0.087 |
| | **Low** | 0.060 | 0.089 | **0.182** |
| Imports | **North** | **0.174** | 0.017 | 0.022 |
| | **Middle Up** | -0.009 | **0.107** | **0.109** |
| | **Middle** | **-0.238** | -0.074 | -0.092 |
| | **Low** | -0.018 | -0.042 | -0.017 |

# 5 Econometric specification

## *5.1 Models*

Now we test how South-South trade affects inter industry wage inequality in developing countries.

**Model I**

The basic regression equation to be estimated is the following:

$$Ineq_{ct} = \beta_1 Y_{ct} + \beta_2 FDI_{ct} + \beta_3 Educ_{ct} + \beta_4 \left( \frac{TradeS}{TradeN} \right)_{ct} + D_c + D_t + \varepsilon_{ct} \qquad (1.1)$$

$c$=1,...67 and $t$=1,...8

Where we expect that $\beta_2 > 0$, $\beta_3 < 0$ and $\beta_4 > 0$

We measure inter industry wage inequality in country $c$ in the period $t$, $Ineq_{ct}$, using the standard deviation of the logarithm of wage by industry (alternatively using a Theil index in a robustness check). Explanatory variables include the supply of human capital in the economy ($Educ_{ct}$) which might affect the relative factor price of skilled and unskilled labor, and so the relative price of labor in skilled intensive industry and in unskilled intensive industry. We expect that an increase in the supply for skill will decrease inter industry wage inequality. We include also foreign direct investment ($FDI_{ct}$) which as Feenstra and Hanson (1997) showed could increase wages in industries intensive in skilled labor. FDI leads to a

transfer of productions from North to South which are skill intensive relatively to the South. Finally we add income per capita ($Y_{ct}$) to control for macro economic development which might act on wage inequality. The shares of trade to North ($TradeN_{ct}$) and to South ($TradeS_{ct}$) to total output in industries are respectively:

$$TradeN_{ct} = \frac{X_{ct}^{N} + M_{ct}^{N}}{Output_{ct}} \text{ and } TradeS_{ct} = \frac{X_{ct}^{S} + M_{ct}^{S}}{Output_{ct}}.$$

We use a within estimator in order to control for country specific heterogeneity $D_c$ which might explain differences in wage inequality among countries. Moreover, in doing this, we are closer to a relationship in change rather than in level which is a more suitable specification.

We use three years averages period in order to control for serial correlations and we add dummies equal to 1 for the period after 1990 $D_t$, we do this since Humberto Lopez (forthcoming in Economics Letters) shows that the relationship growth and income inequality suddenly changed in the 1990s. All the coefficients present robust standard with the White correction.

In the robustness check, we will use the country-industry dimension of the database to test the model above on wages in unskilled-labor intensive industries and in skilled-labor intensive industries rather than on the index of wage inequality. We adopt quantile analyses where we estimate the initial econometric specification for the 25th quantile and 75th quantile in the distribution of wage by industry.

**Model II: Country clusters**

A way to test if the level of income in developing country is determining for the effect of S-S trade versus N-S trade is to test the equation (1.1) for different clusters of countries, low income, middle income and middle up income. Here we obtain the following specifications where we test the

impact of trade flows (in imports and exports) with three sorts of groups of countries $P$ (middle up, middle, low):

$$Ineq_{c\in P,t} = \beta_1 Y_{c\in P,t} + \beta_2 FDI_{c\in P,t} + \beta_3 Educ_{c\in P,t} + \beta_4 \left(\frac{TradeS}{TradeN}\right)_{c\in P,t} + D_{c\in P} + D_t + \varepsilon_{c\in P,t} \quad \text{where P=1, 2, 3 } c = 1,...67 \text{ and } t = 1,...8 \quad (1.2)$$

Where we expect that $\beta_2 > 0$, $\beta_3 < 0$, $\beta_4 < 0$ if $P$ = low and $\beta_4 > 0$ if $P$ = middle up

**Model III: Sector-bias**

We investigate now the potential effect of sector biased technological change. In a first specification, we measure the sector biased technological change using a ratio of labor productivity in unskilled intensive sector on labor productivity in skilled intensive sectors.

We proceed in two steps. First in equation 1.3, we estimate the impact of S-S trade and N-S trade on the sector biased toward unskilled intensive industries, $USBTC_{ct}$, which is the ratio of Labor productivity in unskilled labor intensive sectors (LSL) to labor productivity in skilled labor intensive sectors (HSL)[41].

$$USBTC_{ct} = \alpha_1 Y_{ct} + \alpha_2 FDI_{ct} + \alpha_3 Educ_{ct} + \alpha_4 \left(\frac{TradeS}{TradeN}\right)_{ct} + D_c + D_t + \varepsilon_{ct} \quad (1.3)$$

$c = 1,...67$ and $t = 1,...8$

In the robustness check we deal with technological change using a TFP index which is more appropriate than labor productivity which is strongly correlated with the wage. However this considerably reduces our panel of developing countries.

[41] Unskilled Sector-Bias Technological Change $USBTC = \left[\frac{Labor\ \text{Pr}oductivity\ in\ LSL}{Labor\ \text{Pr}oductivity\ in\ HSL}\right]$

Then, in equation 1.4, we will test simultaneously the impact of S-S versus N-S trade and unskilled sector biased technological change on inter industry wage inequality.

$$Ineq_{ct} = \beta_1 Y_{ct} + \beta_2 FDI_{ct} + \beta_3 Educ_{ct} + \beta_4 \left( \frac{TradeS}{TradeN} \right)_{ct} + \beta_5 USBTC_{ct} + D_c + D_t + \varepsilon_{ct} \qquad \text{where } c = 1,...67 \text{ and } t = 1,...8 \qquad (1.4)$$

So we will get a direct effect of the direction of trade, $\beta_4$, and an indirect effect, through the sector biased technological change, $\alpha_4 * \beta_5$. In fact a proper test of the Haskel and Slaughter (2002) model should consist, in the second test, to use wage inequality among worker as interest variable, since it could appear obvious that increasing labor productivity in a sector relative to another increase relative wages in this sector.

In the section 7 we will use GMM system estimates to control for problem of endogeneity. The regression presented above poses some challenges for estimation. Most explanatory variables (trade openness and foreign direct investment) are likely to be jointly endogenous with wage inequality.

### *5.2 Data*

We use the updated database of Nicita and Olarreaga (2006) which gives us data for bilateral trade, production and added value, and wages by industry. Data on wage inequality also comes from the database where we construct the standard deviation in the log of wages as in several studies (Gindling and Robbins 2001, Rama 2003, Attanasio and al. 2004).

Concerning trade openness we use two measures: a trade ratio on manufacture products (exports and imports of manufactured products on output in manufactured sectors). We also use, as robustness test, a constructed an adjusted trade ratio (closer to the notion of trade

liberalization) for N-S and S-S trade, based on a gravity model (see Annex 6).

We used the data from WDI (2004) to measure foreign direct investment and the data on education come from Barro and Lee (2000). Our sample consists of an unbalanced panel dataset of 67 developing countries. For each, the dataset includes at most 8 observations (and at minimum 2), consisting of 3-year averages spanning the 1976-2002 period. Among the developing countries, 22 are from Sub-Saharan Africa, 12 from Asia, 11 from the Middle East and North Africa, and 22 from Latin America and the Caribbean. Annex 1 provides the full list of countries in the sample.

## 6 OLS Results

### *6.1 South-South trade increases wage inequality for middle income countries*

Table 6 shows results when we adopt the specification of equation (1.2) in using the standard deviation in log of wages (SDLW) by industry. Columns 1 to 4 present results.

The foreign direct investment tends to increase wage inequality as suggested by Feenstra and Hanson (1997). This FDI occurs in sectors often more skill intensive than in the mean of sectors in developing countries. We observe that this concerns only upper middle income countries (column 2) where FDI are more important and where skilled labor is more present. An interesting result concerns the impact of education level. Several studies (Zhu and Trefler 2005) find that the education level increase wage inequality whereas it should increase the supply of educated workers and decrease relatively their remuneration. This result holds when we do not control for time period, but if we add dummies for periods, as in Table 6,

this effect is no longer significant or is conform to the theoretical prediction (significantly negative).

In order to test the effect of the trade orientation, we include the ratio of trade with South relative to trade with North (TSS/TNS). We see that trade with southern countries increase wage inequality relatively to trade with northern countries, an increase of 1% in the share of south trade relative to north trade increase inter industry wage inequality by 0.027%.

**Table 6: S-S Trade versus N-S Trade**

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Sample | All | Upper Middle | Middle | Low |
| Wage inequality | **SDLW** | **SDLW** | **SDLW** | **SDLW** |
| GDP pc | -0.026 | -0.104a | 0.068 | -0.094 |
| | (0.67) | (2.68) | (0.95) | (1.38) |
| FDI | 0.480 | 1.016a | 0.060 | 0.737 |
| | (1.59) | (2.99) | (0.12) | (0.69) |
| Education | -0.044b | -0.038 | 0.005 | -0.107b |
| | (1.99) | (0.70) | (0.08) | (2.08) |
| TSS/TNS | 0.027a | 0.023b | 0.034a | 0.028c |
| | (3.44) | (2.24) | (2.63) | (1.77) |
| Dummy country | Yes | Yes | Yes | Yes |
| Dummy period | Yes | Yes | Yes | Yes |
| Observations | 414 | 96 | 179 | 139 |
| Number of countries | 67 | 13 | 25 | 29 |
| R-squared | 0.19 | 0.51 | 0.13 | 0.25 |

All the estimations present robust standard errors. Absolute value of t statistics in parentheses. c significant at 10%; b significant at 5%; a significant at 1%.

A first candidate explanation for this result would be the existence of a North-South trade relationship (e.g. inter industry specialization), among developing countries. Therefore South-South trade would be increasing wage inequality for middle income countries (like for the North in N-S trade) and decreasing inequality for low income countries. We observe that this effect is more significant for middle income countries (column 2, 3) than for low income countries (column 4) as we could expect since low

income countries present a comparative advantage in unskilled labor relatively to all the other southern countries.

### *6.2 Sector biased technological change matter*

Table 7 shows us the estimations of equation (1.3). We observe that trading with southern countries rather than with northern countries decreases the biased in technological change toward unskilled intensive sector (USBTC), although this effect is not significant for middle income countries. This comforts our assumption concerning the fact that S-S trade increases competition and labor productivity in mildly skill (MSL) and high skill (HSL) industries whereas N-S trade increases competition and labor productivity in low skill intensive (LSL) industries. However the within R squared in our regression is low, except for middle up income countries (column 2) so those results must be taken with caution.

**Table 7: Effect of S-S and N-S trade on sector biased technical change**

| | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Sample | All | Upper Middle | Middle | Low |
| | **USBTC** | **USBTC** | **USBTC** | **USBTC** |
| GDP pc | -0.146 | 0.249 | -0.256 | -0.079 |
| | (0.73) | (0.89) | (0.81) | (0.20) |
| FDI | -1.658 | -4.370 | -1.855 | 4.936 |
| | (0.71) | (1.40) | (0.41) | (1.14) |
| Education | 0.248c | -0.617 | 0.063 | 0.336c |
| | (1.82) | (1.25) | (0.18) | (1.83) |
| TSS/TNS | -0.083b | -0.071c | -0.022 | -0.175b |
| | (2.15) | (1.83) | (0.28) | (2.13) |
| Dummy country | Yes | Yes | Yes | Yes |
| Dummy period | Yes | Yes | Yes | Yes |
| Observations | 414 | 96 | 179 | 139 |
| Number countries | 67 | 13 | 25 | 29 |
| R-squared | 0.09 | 0.32 | 0.08 | 0.10 |

All the estimations present robust standard errors. Absolute value of t statistics in parentheses. c significant at 10%; b significant at 5%; a significant at 1%.

Next we observe the impact of this sector biased technological change on wage inequality in table 8 (equation 1.4). As expected this sector biased technological change toward unskilled intensive sector decrease wage inequality across industries, for all group of countries. Once we account for the effect though sector biased technological change the results on S-S trade versus N-S trade holds for middle income countries. Here again there is not significant effect for low income countries meaning that for low income countries the increasing effect on wage inequality of S-S trade occurs only through the sector biased technological change, whereas for other groups of countries, they have both effect, direct and indirect.

**Table 8: Direct and Indirect effects of N-S and S-S trade on wage inequality**

| | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Sample | All | Upper Middle | Middle | Low |
| wage inequality | **SDLW** | **SDLW** | **SDLW** | **SDLW** |
| GDP pc | -0.071c | -0.070b | 0.002 | -0.186a |
| | (1.89) | (2.06) | (0.03) | (3.12) |
| FDI | 0.291 | 0.713b | 0.019 | 0.883 |
| | (1.08) | (2.01) | (0.05) | (1.18) |
| Education | -0.043 | -0.024 | -0.032 | -0.059 |
| | (1.07) | (0.45) | (0.43) | (1.16) |
| USBTC | -0.078a | -0.048b | -0.062a | -0.137a |
| | (4.85) | (2.45) | (3.25) | (5.40) |
| TSS/TNS | 0.023a | 0.020c | 0.031b | 0.014 |
| | (3.26) | (1.82) | (2.14) | (1.43) |
| Dummy country | Yes | Yes | Yes | Yes |
| Dummy period | Yes | Yes | Yes | Yes |
| Observations | 414 | 96 | 179 | 139 |
| Number countries | 67 | 13 | 25 | 29 |
| R-squared | 0.30 | 0.55 | 0.18 | 0.52 |

All the estimations present robust standard errors. Absolute value of t statistics in parentheses. c significant at 10%; b significant at 5%; a significant at 1%.

The global effect (indirect and direct) of S-S trade relative to N-S trade is given in Table 9[42]. Hence we observe that being oriented toward S-S trade rather than N-S trade affect mainly directly the middle income countries since they not present a comparative advantage in unskilled labor and have decreasing wage premium in their unskilled intensive industry following trade liberalization. The effect through the sector biased technological change toward skilled intensive sectors is mainly important for the low income countries. This indirect effect is more important in low income countries (63% versus 37%) whereas in middle income countries the direct effect is the highest (around 90%). However the comparison between upper middle and middle income countries does not confirm our expectations since the direct effect is more important for middle income countries.

**Table 9: Quantify the indirect and direct effect of S-S trade relative to N-S trade on wage inequality**

| Effect of SS/NS | All | Upper Middle | Middle | Low |
|---|---|---|---|---|
| Indirect effect | 0.007 | 0.004 | *0.002* | 0.028 |
| Direct effect | 0.025 | 0.022 | 0.037 | *0.017* |
| Total effect | 0.032 | 0.026 | 0.039 | 0.045 |
| Share Indirect | 22% | 15% | 4% | 63% |
| Share Direct | 78% | 85% | 96% | 37% |

Calculated from table 7 and 8. Value in italics means that it is not significant

### *6.3 Quantile estimations on industries*

We are also interested, as robustness test, in analyzing directly variation in wage by industry rather than through an index of wage inequality. Here we could use the mean wage for different clusters, as used

[42] calculated in using standard error of TSS/TNS multiplying by its coefficient in the first regression and by the coefficient in front of USBTC in the second (the indirect effect) and we add the standard error multiplied by its coefficient in the second regression as direct effect. For example, in the first column (all developing countries) with a standard error of 1.07 the indirect effect is 1.07*(-0.083)*(-0.078) = 0.007 and the direct effect is 1.07*0.023 = 0.025 meaning a global effect of 0.032.

for the descriptive statistics: unskilled labor intensive, mildly skilled labor intensive and high skilled labor intensive. However by doing this we loose information on changes among industries. That is why we adopt quantile analyses where we estimate the initial econometric specification for the 25th quantile and 75th quantile in the distribution of wage by industry. This allows us to test the impact on wage of both global –level orientation in trade and of sector-level orientation in trade. In this specification on wages by industry we use three years averages period in order to control for serial correlations and we also add dummies by industry and by period.

Those results on the industry database where we estimate quantile regressions on wage by industry (Annex 4.1) comfort previous results. We show in columns 1 and 2 that South-South trade relatively to North-South trade decreases inequality for the 25th percentile of wage more than for the 75th percentile of wage (-0.063 versus -0.034) meaning that this increases wage inequality[43]. We observe the same impact on the different clusters of developing countries (columns 3 to 6), except for the low income countries (columns 7 and 8) where the impact is inversed[44]. As suggested in the previous part, low income countries present a comparative advantage in unskilled labor relatively to all the other southern countries[45]. The quantile estimations on Labor productivity (Annex 4.2) show, that South-South trade relatively to North-South trade increases more labor productivity in sectors where this labor productivity is already the highest and decreases labor productivity in low productivity sectors.

[43] An inter-quantile regression shows that a 1% increase in the share of south trade relative to north trade increases difference in wages between the 25th and 75th quantile of 0.029%.
[44] The interquantile regressions show that a1% increase in the share of south trade relative to north trade increases difference in wages between the 25th and 75th quantile of 0.050% and 0.048% respectively.
[45] An inter-quantile regression shows that a 1% increase in the share of south trade relative to north trade decreases difference in wages between the 25th and 75th quantile of 0.047%.

### *6.4 TFP rather than Labor productivity*

In the previous estimates, we do not use a TFP index as measure of technological change since this considerably reduces our panel of developing countries. Moreover we do not have the capital stock and estimating this capital stock requires assumptions. I adopt the procedure of Keller (1997) for the perpetual inventory method which is very critizable since estimation of initial capital stock is based on gross fixed capital formation after the initial year. However if we deal with technological change, using TFP index is more appropriate than using labor productivity which strongly correlated with wage. Then we use the industry dimension of our database to apply our two steps strategy on the three clusters of industries (highly skill-intensive, medium skill-intensive and low skill-intensive) for 38 developing countries for which we have TFP in industries.

We observe in annex 5.1 that an increase in S-S trade relative to N-S trade increases TFP more in the high skill-intensive sector (HSL) than in the low skill-intensive sectors (LSL), and this effect is very huge for low income countries. Then when we include both TFP and trade in the second step (annex 5.2), we observe that the direct effect of S-S trade versus N-S trade is still important and for low income countries the indirect effect (through the TFP) is most important than for other group of countries. The measure of both impacts in annex 5.3 show that for upper middle income countries the direct effect represent 85% of total effect of S-S trade versus N-S trade whereas for low income countries the indirect effect represent roughly 40% of total effect.

### *6.5 Robustness check*

We check the robustness of our results using other dataset and measure for wage inequality and openness to trade in Annex 7. The Theil index on inter-industrial wage differences, created by James Galbraith and associates covers on average about 90 countries annually over the period 1975-99. We also construct a new measure of trade openness based on a gravity model (annex 6) as suggested by Hiscox and Kastner (2002).

In column 1 we present the trade ratio for South-South trade and for North-South trade in industry for all developing countries rather than the previous ratio (S-S trade/ N-S trade). As expected S-S trade increases wage inequality whereas N-S trade decreases wage inequality (but not significantly). Then, in column 2, we use the Theil index on wage from UTIP database as output variable and the previous ratio (S-S trade/ N-S trade), the result are conformed to the previous results (column 1 of table 3.1). The columns 3 and 4 show that trade openness, measured by our index of trade liberalization, decreases wage inequality in developing countries in case of trade liberalization with northern partners and increases wage inequality in case of trade liberalization with southern partners, whatever is the index of wage inequality, standard deviation in log of wages (column 3) or Theil index from UTIP database (column 4).

We have also tried to use another approach to measure N-S trade versus S-S trade for developing countries[46]. We could consider S-S trade as openness with a partner less endowed in human capital (measure by the average years of education from Barro and Lee 2000), and N-S trade as openness with a partner more endowed in human capital. Then each developing country faces different partners for South and for North.

[46] Thanks to Marcelo Olarreaga and Mathias Thoenig for this comment

Unfortunately this approach gives no consistent results since the measure mainly captures the endowment of countries in human capital, e.g. country with low endowment in capital has mainly North partners so N-S trade.

## 7 GMM System

The regression presented above poses some challenges for estimation. The first is that most explanatory variables (trade openness and foreign direct investment) are likely to be jointly endogenous with wage inequality, so we need to control for the biases resulting from simultaneous or reverse causation. We use the generalized method of moments (GMM) estimators developed for dynamic models of panel data that were introduced by Arellano and Bond (1991). Blundell and Bond (1997) show that when the explanatory variables are persistent over time, lagged levels of these variables are weak instruments for the regression equation in differences. And in our model education level or trade orientation for example are more persistent over time than the usual explanatory variables. To reduce the potential biases and imprecision associated with the usual difference estimator, we also use the GMM system estimator that combines the regression in differences and the regression in levels into one system (developed in Arellano and Bover, 1995, and Blundell and Bond, 1997).

We consider FDI and Trade Openness as likely endogenous variables so we use the second and third lag as instruments; Education and GDP per capita are assumed to be pre-determined, we use the first lag as instruments. Using lagged variables necessitates having an important number of observations. That is why we use a yearly database rather than the three years averages period database for this GMM estimator. Otherwise we loose too many observations.

The consistency of the GMM estimators depends on whether lagged values of the explanatory variables are valid instruments in the growth regression. We address this issue by considering two specification tests suggested by Arellano and Bond (1991). The first is a Sargan test of overidentifying restrictions, which tests the overall validity of the instruments by analyzing the sample analog of the moment conditions used in the estimation process. Failure to reject the null hypothesis gives support to the model. The second test examines the null hypothesis that the error term, is not serially correlated. As in the case of the Sargan test, the model specification is supported when the null hypothesis is not rejected. In the system specification, we test whether the differenced error term (that is, the residual of the regression in differences) is second-order serially correlated.

**Table 10: S-S Trade versus N-S Trade**

| | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Sample | GMM-SY All | GMM-SY Upper Middle | GMM-SY Middle | GMM-SY Low |
| wage inequality | **SDLW** | **SDLW** | **SDLW** | **SDLW** |
| GDP pc | -0.017 | 0.004 | 0.032 | -0.005 |
| | (0.88) | (0.30) | (1.63) | (0.14) |
| FDI | 0.063 | 0.094a | 0.133 | 0.174 |
| | (1.18) | (4.20) | (1.36) | (0.87) |
| Education | 0.002 | -0.088a | 0.058b | 0.053 |
| | (0.06) | (3.52) | (2.02) | (1.62) |
| TSS/TNS | 0.047a | 0.055a | 0.029c | 0.028c |
| | (4.58) | (10.22) | (1.72) | (1.72) |
| Dummy year | Yes | Yes | Yes | Yes |
| Observations | 1036 | 280 | 466 | 290 |
| Number country | 61 | 13 | 24 | 24 |
| Prob Sargan | 0.77 | 0.74 | 0.53 | 0.13 |
| AR2 | 0.61 | 0.48 | 0.43 | 0.90 |

Absolute value of t statistics in parentheses.
c significant at 10%; b significant at 5%; a significant at 1%.

The columns 1 to 4 in table 10 present results with the GMM-system estimator on the yearly dataset. We see that trade with southern countries

increase wage inequality relatively to trade with northern countries, an increase of 1% in the share of south trade relative to north trade increase inter industry wage inequality of 0.047%. We observe that this effect is more significant for upper middle income countries (0.055 in column 2,) than for lower middle income countries (0.029 in column 3) or low income countries (0.028 in column 4).

Table 11 shows that, as in the previous results, trading with southern countries rather than with northern countries decreases the bias in technological change toward un skilled intensive sector, and this effect is more important for low income countries (-0.201 in column 4) than for middle income countries (-0.169 in column 3) and for upper middle income countries (-0.107 in column 2).

**Table 11: Effect of S-S and N-S trade on sector biased technical change**

| | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Sample | GMM-SY All | GMM-SY Upper Middle | GMM-SY Middle | GMM-SY Low |
| | **USBTC** | **USBTC** | **USBTC** | **USBTC** |
| GDP pc | -0.001 | 0.086 | -0.312 | 0.146 |
| | (0.01) | (0.26) | (1.30) | (0.57) |
| FDI | -0.225 | -0.338 | -0.625 | 0.513 |
| | (1.34) | (1.19) | (0.96) | (0.74) |
| Education | -0.410a | -0.152 | -0.610c | -0.586a |
| | (3.03) | (0.30) | (1.81) | (4.89) |
| TSS/TNS | -0.090c | -0.107c | -0.169b | -0.201b |
| | (1.69) | (1.74) | (2.20) | (2.22) |
| Dummy year | Yes | Yes | Yes | Yes |
| Observations | 1036 | 280 | 466 | 290 |
| Number of country | 61 | 13 | 24 | 24 |
| Prob Sargan | 1.00 | 1.00 | 1.00 | 1.00 |
| AR2 | 0.54 | 0.67 | 0.82 | 0.40 |

Absolute value of t statistics in parentheses. c significant at 10%; b significant at 5%; a significant at 1%.

Table 12 shows here again that for low income countries (column 4) the increasing effect on wage inequality of S-S trade occurs mainly through the sector biased technological change, whereas for middle income countries (column 3), they have both effects, direct and indirect. In upper middle income countries (column 2) only the direct effect is significant.

**Table 12: Direct and Indirect effects**

| | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| | GMM-SY | GMM-SY | GMM-SY | GMM-SY |
| Sample | All | Upper Middle | Middle | Low |
| wage inequality | **SDLW** | **SDLW** | **SDLW** | **SDLW** |
| GDP pc | -0.019 | 0.003 | 0.003 | -0.100a |
| | (0.98) | (0.12) | (0.10) | (3.13) |
| FDI | 0.079c | 0.091 | 0.099 | 0.454a |
| | (1.68) | (1.54) | (0.86) | (3.18) |
| Education | -0.025 | -0.097 | 0.002 | 0.027 |
| | (0.91) | (1.18) | (0.05) | (0.75) |
| USBTC | -0.059b | -0.011 | -0.088a | -0.049c |
| | (2.53) | (1.62) | (3.55) | (1.85) |
| TSS/TNS | 0.041a | 0.057a | 0.032c | 0.010 |
| | (4.47) | (3.57) | (1.89) | (0.97) |
| Dummy year | Yes | Yes | Yes | Yes |
| Observations | 1036 | 280 | 466 | 290 |
| Number of country | 61 | 13 | 24 | 24 |
| Prob Sargan | 1.00 | 1.00 | 1.00 | 1.00 |
| AR2 | 0.53 | 0.62 | 0.46 | 0.67 |

Absolute value of t statistics in parentheses.
c significant at 10%; b significant at 5%; a significant at 1%.

The global effect (indirect and direct) of S-S trade relative to N-S trade is given in Table 13. The indirect effect is more important in low income countries (50%) than in the middle income countries (31%) and upper middle income countries (2%).

Results for upper middle and middle income countries are more in line with our expectations with the GMM estimator than with the OLS estimator.

**Table 13: Quantify the indirect and direct effect**

| Effect of SS/NS | All | Upper Middle | Middle | Low |
|---|---|---|---|---|
| Indirect effect | 0.006 | *0.001* | 0.015 | 0.013 |
| Direct effect | 0.046 | 0.062 | 0.034 | *0.013* |
| Total effect | 0.052 | 0.063 | 0.049 | 0.026 |
| Share Indirect | 11% | 2% | 31% | 50% |
| Share Direct | 89% | 98% | 69% | 50% |

Calculated from table 11 and 12. Value in italics means that it is not significant

## 8 Conclusions

This chapter addresses the puzzle why the wage skill gap often increased in developing countries when they liberalized their trade. Faced with this result, authors have improved their empirical assessment and their theoretical approach to studying the consequences of trade liberalization. They account notably for skill biased technological change during trade liberalization. Here we propose another explanation: the direction of trade. In a context where globalization does not only lead to an increase in North-South trade but also in South-South trade, it seems important to account for this change in the direction of trade when analyzing the impact on inequality. South-South trade account now 40% of merchandise trade in developing countries.

Our main results are first that increasing share of S-S trade increases wage inequality whereas N-S trade tends to decrease inter industry wage inequality for all developing countries. Second a part of this increasing wage inequality due to S-S trade comes from the development of N-S trade relationship in S-S trade which increases wage inequality in middle income developing countries (which are the North in this S-S trade). Third, the fact that S-S trade leads more to a technological change biased toward skill intensive sector increase wage inequality for all developing countries

(included low income countries). Fourth, whereas for middle income country the impact of S-S trade on increasing wage inequality is mainly direct (through the fact that they are the North in this S-S trade), for low income countries it is the indirect effect through the sector biased technological change which impact more on wage inequality.

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# APPENDICES

***A.1:*** *List of countries included in the sample 1976-2000*

| | Countries | observations |
|---|---|---|
| Middle Up Income Countries | Argentina | 7 |
| | Barbados | 7 |
| | Chile | 8 |
| | Costa Rica | 7 |
| | Israel | 5 |
| | Korea, Rep. | 7 |
| | Malaysia | 8 |
| | Mauritius | 7 |
| | Mexico | 8 |
| | Panama | 8 |
| | Trinidad & Tobago | 8 |
| | Uruguay | 8 |
| | Venezuela, RB | 8 |
| **Total** | **13** | **96** |

| | Countries | observations |
|---|---|---|
| Middle Income Countries | Algeria | 7 |
| | Bolivia | 8 |
| | Brazil | 4 |
| | China | 4 |
| | Colombia | 8 |
| | Dominican Rep. | 4 |
| | Ecuador | 8 |
| | Egypt, Arab Rep. | 8 |
| | El Salvador | 7 |
| | Fiji | 7 |
| | Guatemala | 8 |
| | Honduras | 7 |
| | Indonesia | 8 |
| | Iran, Islamic Rep. | 8 |
| | Jamaica | 7 |
| | Jordan | 8 |
| | Morocco | 8 |
| | Peru | 7 |
| | Philippines | 8 |
| | South Africa | 8 |
| | Sri Lanka | 7 |
| | Syria | 8 |
| | Thailand | 8 |
| | Tunisia | 7 |
| | Turkey | 7 |
| **Total** | **25** | **179** |

| | Countries | observations |
|---|---|---|
| Low Income Countries | Bangladesh | 7 |
| | Benin | 2 |
| | Burundi | 2 |
| | Cameroon | 7 |
| | Central African Rep | 6 |
| | Congo | 4 |
| | Ethiopia | 3 |
| | Gambia, The | 3 |
| | Ghana | 6 |
| | Guyana | 2 |
| | Haiti | 3 |
| | India | 7 |
| | Ivory Coast | 5 |
| | Kenya | 8 |
| | Liberia | 2 |
| | Madagascar | 5 |
| | Malawi | 7 |
| | Nepal | 5 |
| | Nicaragua | 4 |
| | Nigeria | 6 |
| | Pakistan | 7 |
| | Papua New Guinea | 5 |
| | Rwanda | 5 |
| | Senegal | 7 |
| | Sierra Leone | 2 |
| | Tanzania | 4 |
| | Togo | 5 |
| | Zambia | 4 |
| | Zimbabwe | 6 |
| **Total** | **29** | **139** |

***A.2:*** *Classification of Isic Industry according to Skill Intensity*

| Label | 3-digit ISIC | Content |
|---|---|---|
| Low Skill Labor Intensive (LSL) | 311 | Food products |
| | 321 | Textiles |
| | 322 | Wearing apparel, except footwear |
| | 323 | Leather products |
| | 324 | Footwear, except rubber or plastic |
| | 331 | Wood products, except furniture |
| | 332 | Furniture, except metal |
| | 356 | Plastic products |
| Medium Skill Labor Intensive (MSL) | 313 | Beverages |
| | 314 | Tobacco |
| | 341 | Paper and products |
| | 342 | Printing and publishing |
| | 355 | Rubber products |
| | 361 | Pottery, china, earthenware |
| | 362 | Glass and products |
| | 369 | Other non-metallic mineral products |
| | 371 | Iron and steel |
| | 372 | Non-ferrous metals |
| | 381 | Fabricated metal products |
| High Skill Labor Intensive (HSL) | 351 | Industrial chemicals |
| | 352 | Other chemicals |
| | 353 | Petroleum refineries |
| | 354 | Miscellaneous petroleum and coal products |
| | 382 | Machinery, except electrical |
| | 383 | Machinery, electric |
| | 384 | Transport equipment |
| | 385 | Professional and scientific equipment |

### *A.3:* *List of variables*

| Label | Content | Sources |
|---|---|---|
| Theil | Theil index on inter industry wage inequality | UTIP (2004) |
| SDLW | Standard Deviation of log wages per Industry (measure inter industry wage inequality) | Nicita and Olarreaga (2006) |
| Wage | Wage by industry | Nicita and Olarreaga (2006) |
| FDI | Foreign Direct Investment | WDI (2004) |
| GDPpc | GDP per capita in power parity purchase (PPP) | Pen WorldTables (2005) |
| Capital | Capital per Worker | Easterly and Levine (1999) & Kraay and al. (2000) |
| Arable Land | Land arable per labor force (Cereal-land; Crop-land; Forest-land) | WDI (2004) |
| Mining & Fuel | Index Isham and al. (2005) base on net exports | Comtrade (2002) |
| Education | Average years of schooling in the population over 15 years old | Barro and Lee (2000) |
| Infrastructure | Principal component analysis on road per km², telephone lines per workers, power Gigawatt per worker | Caning (19996) and Calderon and Serven (2004) |
| Density | Population on Surface | WDI (2004) |
| Tariffs | Import duties comprise all levies collected on goods at the point of entry into the country. In % of Imports | WDI (2004) |
| (X+M)/Gdp | Output trade ratio | WDI (2004) |
| Index South | Adjusted Trade ratio on bilateral trade with South Countries | Calculate by author |
| Index North | Adjusted Trade ratio on bilateral trade with North Countries | Calculate by author |
| Trade South (TSS) | Imports from South and Export to South on Added Value in manufacturing industry | Nicita and Olarreaga (2006) |
| Trade North (TNS) | Imports from North and Export to North on Added Value in manufacturing industry | Nicita and Olarreaga (2006) |
| TSS/TNS | Openness biased toward South | Calculate by author from Nicita and Olarreaga (2006) |
| Labor productivity | Added value per Labor | Nicita and Olarreaga (2006) |
| USBTC | Ratio of Labor productivity in Low Skill Labor intensive industry on Labor productivity in High Skill Labor intensive industry | Calculate by author from Nicita and Olarreaga (2006) |
| Tot Factor Productivity (TFP) | The TFP is calculated un logs as the difference between output and factor use: log *TFP* = logY - ***a*** log *L* - (1-a) log K, with a equal to labor's share. The capital stocks are derived from investment series using the perpetual inventory model with a 9% depreciation rate. The labor share is equal to the wage bill divided by the value of output. | Calculate by author from Nicita and Olarreaga (2006) with Mathias Thoenig method |

### *A.4:* *Quantile Regressions*

**A.4.1**: S-S Trade versus N-S Trade

| | All | | Upper Middle | | Middle | | Low | |
|---|---|---|---|---|---|---|---|---|
| | **1** Wage (25th) | **2** Wage (75th) | **3** Wage (25th) | **4** Wage (75th) | **5** Wage (25th) | **6** Wage (75th) | **7** Wage (25th) | **8** Wage (75th) |
| GDP pc | 0.7754a | 0.6408a | 1.1335a | 0.9397a | 0.5147a | 0.4593a | 0.7402a | 0.4648a |
| | (18.47) | (18.32) | (15.79) | (15.51) | (11.18) | (7.87) | (9.69) | (6.09) |
| FDI | -0.7924c | -1.7228a | -1.3815b | -2.0310a | 1.0674b | -2.1947a | -7.5166a | -5.0562a |
| | (1.84) | (4.93) | (2.58) | (3.90) | (2.07) | (3.62) | (7.36) | (5.67) |
| Education | 0.0628 | 0.1941a | -0.0524 | -0.0317 | 0.1511a | 0.4718a | -0.0823 | -0.1682b |
| | (1.35) | (4.87) | (0.49) | (0.31) | (3.02) | (6.95) | (1.25) | (2.45) |
| TSS/TNS | -0.0630a | -0.0339a | -0.0577a | -0.0076 | -0.1551a | -0.1066a | 0.0971a | 0.0503a |
| | (5.72) | (3.76) | (2.63) | (0.42) | (12.48) | (6.86) | (5.68) | (2.92) |
| D industry | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| D country | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| D period | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | -5.2705a | -3.6806a | -7.8395a | -5.6404a | -3.5532a | -3.1540a | -3.7993a | -2.4101a |
| | (20.98) | (17.50) | (12.76) | (10.48) | (9.95) | (6.79) | (10.81) | (6.90) |
| Observations | 9181 | 9181 | 2295 | 2295 | 4102 | 4102 | 2784 | 2784 |
| $R^2$ | 0.56 | 0.56 | 0.54 | 0.54 | 0.57 | 0.57 | 0.56 | 0.56 |

**A.4.2:** Effect of S-S and N-S trade on sector biased technological change

| | Labor Productivity (25%) | Labor Productivity (75%) |
|---|---|---|
| GDP pc | 0.758 | 0.531 |
| | (18.08)*** | (10.05)*** |
| FDI | -2.680 | -1.600 |
| | (6.05)*** | (3.09)*** |
| Education | 0.169 | 0.252 |
| | (3.48)*** | (4.34)*** |
| TSS/TNS | -0.018 | 0.032 |
| | (1.64) | (2.49)** |
| Dummy industry | Yes | Yes |
| Dummy country | Yes | Yes |
| Dummy period | Yes | Yes |
| Constant | -4.778 | -2.497 |
| | (12.72)*** | (5.25)*** |
| Observations | 9181 | 9181 |

### *A.5:* *Total Factor Productivity (TFP)*

**A.5.1:** Effect of S-S and N-S trade on sector biased technological change

| Countries | Developing | | | Upper middle | | Low | |
|---|---|---|---|---|---|---|---|
| Skill intensive | LSL | MSL | HSL | LSL | HSL | LSL | HSL |
| | **TFP** | **TFP** | **TFP** | **TFP** | **TFP** | **TFP** | **TFP** |
| GDP pc | 1.0849a | 1.1320a | 1.4076a | 0.7515a | 1.0878a | 2.2330a | 2.2267a |
| | (12.57) | (12.52) | (11.71) | (7.95) | (6.09) | (7.38) | (6.22) |
| Education | -0.1116 | -0.2806a | -0.3316b | 0.0378 | -0.6868b | -1.1146a | 3.0431a |
| | (1.10) | (2.65) | (2.36) | (0.24) | (2.46) | (2.68) | (5.43) |
| FDI | 0.1716b | 0.1993a | 0.1544 | 0.0171 | -0.2546b | -2.8683a | -2.5677b |
| | (2.47) | (2.70) | (1.54) | (0.32) | (2.40) | (2.91) | (2.34) |
| TSS/TNS | -0.0223 | 0.0589b | 0.0883a | 0.0391 | 0.1030 | 0.1041 | 0.3944a |
| | (0.98) | (2.47) | (2.77) | (1.21) | (1.58) | (1.08) | (3.50) |
| Dummy industry | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Dummy country | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Dummy period | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 4489 | 6003 | 4107 | 1334 | 1242 | 885 | 719 |
| Number | 292 | 389 | 275 | 80 | 79 | 71 | 62 |
| R-squared | 0.17 | 0.21 | 0.23 | 0.39 | 0.32 | 0.23 | 0.35 |

**Annex 5.2**: Direct and Indirect effects of N-S and S-S trade on wage inequality

| Countries | Developing | | | Upper middle | | Low | |
|---|---|---|---|---|---|---|---|
| Skill intensive | LSL | MSL | HSL | LSL | HSL | LSL | HSL |
| | **wage** | **wage** | **wage** | **wage** | **wage** | **wage** | **wage** |
| GDP pc | 0.6374a | 0.5108a | 0.5967a | 0.9686a | 0.7404a | 0.2743 | 0.0859 |
| | (2.95) | (2.62) | (2.59) | (5.08) | (3.33) | (1.42) | (0.94) |
| Education | 0.0138 | -0.1214 | -0.1398a | 0.1143 | -0.1766c | 0.3972c | 0.4191a |
| | (0.34) | (1.02) | (2.77) | (1.27) | (1.71) | (1.93) | (2.47) |
| FDI | 0.0127 | 0.0219 | 0.0691c | -0.1315a | -0.1023a | 0.0604 | 0.6560c |
| | (0.45) | (0.78) | (1.93) | (2.27) | (2.61) | (0.22) | (1.95) |
| TSS/TNS | -0.0784a | -0.0858a | -0.0596a | -0.1283a | -0.1071a | 0.0218 | 0.0345 |
| | (2.88) | (3.44) | (2.93) | (2.33) | (1.97) | (0.75) | (1.32) |
| TFP | 0.2275a | 0.1332a | 0.1129a | 0.3395a | 0.1329a | 0.1231a | 0.0731a |
| | (3.74) | (3.59) | (4.47) | (4.48) | (2.85) | (3.32) | (2.23) |
| Dummy industry | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Dummy country | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Dummy period | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 4489 | 6003 | 4107 | 1334 | 1242 | 885 | 719 |
| Number | 292 | 389 | 275 | 80 | 79 | 71 | 62 |
| R-squared | 0.42 | 0.36 | 0.36 | 0.58 | 0.54 | 0.39 | 0.47 |

**Annex 5.3** Quantify the effects Effect of 1% increase in the ratio TSS/TNS[47]

| | Developing | | | Upper middle | | Low | |
|---|---|---|---|---|---|---|---|
| | LSL | MSL | HSL | LSL | HSL | LSL | HSL |
| **Direct** | -0.0784 | -0.0858 | -0.0596 | -0.1283 | -0.1071 | *0.0218* | *0.0345* |
| **Indirect** | *-0.0051* | 0.0078 | 0.0100 | *0.0133* | *0.0137* | 0.0128 | 0.0288 |
| **Total** | - 0.0835 | -0.0780 | -0.0496 | -0.1150 | -0.0926 | 0.0346 | 0.0633 |

[47] value in italic indicates that it is not significant

***A.6:*** *Adjusted trade openness index*

The basic gravity model posits that the volume of trade between two nations is an increasing function of the incomes of those nations and a decreasing function of the distance between them. Although we include other variables, including whether the countries share a common border and/or a common language are often added to the model. Frankel and Romer (1999) use it to estimate the natural openness in a country. By implication, the model should also be able to help us in identifying abnormal or distorted patterns of trade and estimating the extent to which these are due to the trade policies of particular nations. The basic form of the gravity model can be expressed in log-linear form as

$$\ln\left(\frac{(M+X)_{ijt}}{Y_{it}}\right) = \alpha_{it} + \beta_1 \ln Y_{jt} + \beta_2 \ln(P_{it} * P_{jt}) + \beta_3 Dist_{ijt} + \beta_4 \ln K_{ijt} + \beta_5 \ln N_{ijt} + \beta_6 \ln T_{ijt} + \beta_7 \ln H_{ijt} + \beta_8 \ln(R_{it} * R_{jt}) + \beta_9 Z_{ij} + \varepsilon_{it}$$

Where $(M+X)_{ijt}$ represents total trade flow between country *i* and *j*, $Y_{it}$ and $Y_{jt}$ denote national income, $P_{it}$ and $P_{jt}$ are total population, $Dist_{ijt}$ is the distance between economic centers of each country. $Z_{ij}$ represents dummies including whether the countries share a common border and/or a common language, are landlocked or exporter of oil. The Heckscher-Ohlin (HO) model of trade suggests that trade flows should vary with the character of each nation's factor endowments relative to trading partners. That is why we include variables that represent differences in factor endowments between countries. $K_{ijt}$, $N_{ijt}$, $T_{ijt}$ and $H_{ijt}$ are differences in factor endowments between countries *i* and *j* in physical capital per labor, mineral/fuel resources per labor, arable land per labor and human capital per labor. We include also the remoteness since a country's trade with any given partner is dependent on its average remoteness to the rest of the world (Anderson and Van Wincoop 2003). Let $R_i$ and $R_j$, denote the remoteness of j and i, equal to GDP-weighted of distance.

In order to evaluate the distorting effects of each country's policies in each year we include a country year dummy $\alpha_{it}$ for country *i* in year *t*. The country-year dummy variables stand in for the (unmeasured) relative openness of trade policy orientations. A similar approach has been used to gauge the effects of regional trade agreements on trade flows by using dummy variables for pairs of nations in the same regional bloc as a proxy for regionally specific discriminatory policies.

Here the set of estimated coefficient $\alpha_{it}$ provides the amount of trade flows due to distorting effects of each country's policies in each year when compared to the mean for the entire sample.

The yearly data set is a panel of bilateral trade flows for 91 countries over the period 1975-1998. The data on trade flows come from Andrew Rose (2004) based on the CD Rom "Direction of Trade" from IMF. The measure of income is the real GDP in 1995 dollar from WDI (2004). The measure on distance comes from CEPII. Measure on capital per worker comes from Easterly and Levine (1999) and Kraay and al. (2000), the measure on arable land par person comes from WDI (2004) and the average years of schooling in the population over 15 years old comes from the Barro and Lee (2000) database. The measure for natural resources is the index from Isham and al. (2005) base on net exports share on fuels and minerals/

To check the robustness of our approach, we also estimate the previous model on imports to country *i* from *j*. So we have four estimations in OLS where columns 1 and 2 deal with total trade flows (imports and exports) with southern and northern countries respectively, column 3 and 4 deal with imports flows.

| | **1** | | **2** | | **3** | | **4** | |
|---|---|---|---|---|---|---|---|---|
| | **S-S** | | **S-N** | | **S-S** | | **S-N** | |
| | (Xij+Mij)/GDPi | | (Xij+Mij)/GDPi | | Mij/GDPi | | Mij/GDPi | |
| | | t | | t | | t | | t |
| GDP j | .8434706 | 136.58 | 1.088825 | 171.48 | .8407659 | 121.89 | 1.096644 | 177.21 |
| Distance ij | -1.567697 | -128.38 | -1.362507 | -69.93 | -1.599144 | -124.18 | -1.269562 | -63.49 |
| Remoteness j | 13.9901 | 22.32 | -11.43796 | -14.96 | 18.12565 | 23.98 | -13.30967 | -17.02 |
| | | | | | | | | |
| Difference in K/L | -.0504299 | -4.23 | .5902252 | 15.89 | -.050749 | -3.79 | .6914029 | 18.07 |
| Difference in AT/L | .2561743 | 31.34 | .0847337 | 8.54 | .2553133 | 29.18 | .0775922 | 7.76 |
| Difference in MF/L | .236932 | 5.63 | -.1345675 | -4.56 | .2708983 | 5.88 | -.0973902 | -3.16 |
| Difference in Ed/L | .2308808 | 9.26 | .4954804 | 11.30 | .2830758 | 7.70 | 1.143677 | 18.50 |
| GDPj/POPj | .4689212 | 36.31 | .0703882 | 1.11 | .4851791 | 32.83 | .2897272 | 4.30 |
| | | | | | | | | |
| Common border | .1728211 | 4.64 | -.8173135 | -6.00 | .1034525 | 2.59 | -1.046493 | -8.60 |
| Colonial relation | .1860693 | 2.24 | .8976046 | 29.58 | .2208701 | 2.64 | .7736648 | 24.96 |
| Common colons | 1.076913 | 32.42 | -.0895179 | -1.44 | 1.140991 | 32.10 | -.2606428 | -4.37 |
| Common language | .2126735 | 9.65 | .4332245 | 20.65 | .2323986 | 10.10 | .4174662 | 19.95 |
| Island | -.1108155 | -3.78 | .2906113 | 9.56 | -.1338648 | -4.38 | .206694 | 6.60 |
| landlockness | -.1997701 | -6.50 | -.0450844 | -2.21 | -.204416 | -5.54 | -.0849352 | -4.18 |
| | | | | | | | | |
| $R^2$ | | | | | | | | |
| Observations | | | | | | | | |

***A.7**: Alternative measures for wage inequality and trade openness*

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Sample | Fixed effect Developing | Fixed effect Developing | Fixed effect Developing | Fixed effect Developing |
| Index of wage inequality | SDLW | Theil | SDLW | Theil |
| GDP pc | -0.061 | -0.376 | -0.058 | -0.402 |
| | (1.39) | (2.23)** | (1.28) | (1.84)* |
| FDI | 0.509 | 4.174 | 0.146 | 2.534 |
| | (1.33) | (2.33)** | (0.40) | (1.54) |
| Education | -0.068 | 0.070 | -0.038 | 0.204 |
| | (2.02)** | (0.44) | (0.76) | (1.05) |
| Open SS | | | 0.023 | 0.066 |
| | | | (2.74)*** | (2.34)** |
| Open NS | | | -0.041 | -0.121 |
| | | | (3.83)*** | (2.61)*** |
| Trade SS | 0.026 | | | |
| | (3.11)*** | | | |
| Trade NS | -0.022 | | | |
| | (1.57) | | | |
| TSS/TNS | | 0.093 | | |
| | | (2.43)** | | |
| Dummy period | Yes | Yes | Yes | Yes |
| Constant | 0.862 | 4.184 | 0.758 | 3.703 |
| | (3.32)*** | (3.58)*** | (2.77)*** | (2.64)*** |
| Observations | 406 | 388 | 329 | 313 |
| Number | 67 | 67 | 52 | 52 |
| R-squared | 0.20 | 0.23 | 0.23 | 0.26 |